GEOLOGICAL SURVEY BRANCH
DEPARTMENT OF MINES AND ENERGY
GOVERNMENT OF NEWFOUNDLAND AND LABRADOR

REPORT OF ACTIVITIES
1991

St. John's, Newfoundland
1991

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Compiled by
C.P.G. Pereira

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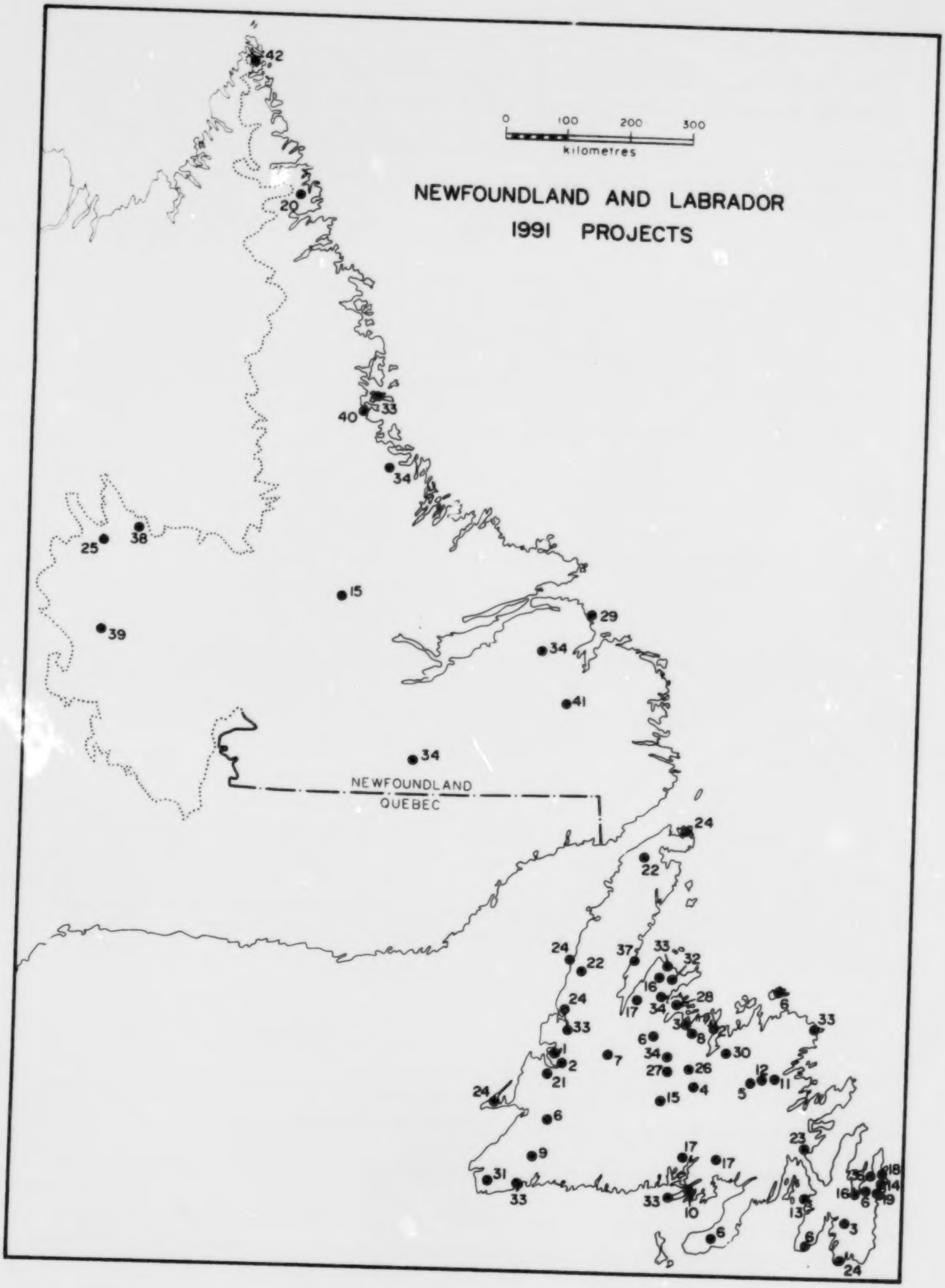
NEWFOUNDLAND AND LABRADOR
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REGIONAL GEOLOGY - NEWFOUNDLAND

MINERAL-CHEMICAL CONSTRAINTS ON THE REACTION/ORIGIN OF ANORTHOSITE AND PYROXENITE AT CONTACTS BETWEEN HOST GABBRO-NORITE AND ULTRAMAFIC SILLS IN THE LOWER CRUST OF THE BAY OF ISLANDS OPHIOLITE

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Synkinematic ultramafic sills, emplaced within the lower half of the ophiolitic crust of the North Arm Complex, Bay of Islands ophiolite, are commonly separated from host gabbro-norites by pyroxenitic or anorthositic reaction rims. Pyroxenes in the reaction rims and the immediately adjacent host gabbros have low Ti-contents similar to those in the peridotite. In contrast, typical gabbroic pyroxenes have lower Mg# and higher Ti than those in the reaction rims, although the Cr-contents remain low, and are comparable to those in the gabbros. Feldspar in the pyroxenite rims and in the contact gabbros are reverse zoned and commonly very calcic (up to An_{98}). The low-Ti CPX and high-An plagioclase imply re-equilibration with the ultramafic intrusion, although the low Cr-content suggests that the chemical input was relatively minor. Hybrid olivine gabbro are commonly present where reaction rims have been removed. Textures imply dissolution and partial melting of the host gabbro-norite. Mixing on the scale of inter-grain pores between anatectic melts in host gabbros and infiltrating intrusive magmas is probably responsible for production of pyroxenitic by-products; this happens because mixtures are in the pyroxene-only phase field in the Ol-An-Di or -Qz systems. Minerals in the common crustal pyroxenites (10 to 30 percent of lower crust in places) have compositions similar to those of the insitu reaction rims, suggesting that they too are partly digested gabbros. This implies that the lower part of the gabbroic crust became denser by the intrusion of ultramafic sill-swarms. Above a certain stratigraphic height, anorthositic reaction rims were found instead of pyroxenite. The anorthositic rocks also have CPX's with low Ti and high Mg#, suggesting that they too are a kind of partial assimilation restite. Their origin may be related to the pressure dependent contraction of the CPX liquidus volume, so that intrusions driven by assimilation processes to co-saturation in OL+ CPX+PLAG+OPX at conditions appropriate for the lower crust, may find themselves in the feldspar-only liquidus volume, if they ascend to higher levels.

PALEONTOLOGICAL INVESTIGATIONS IN NEWFOUNDLAND, 1991

W.D. Boyce, J.S. Ash, I. Knight and J.W. Botsford[1]
Newfoundland Mapping Section

WESTERN NEWFOUNDLAND

Old Mans Pond - Goose Arm - North Arm

In 1990, fifty-seven new macrofossil horizons were discovered in the Penguin Cove, March Point, Petit Jardin and Berry Head formations along Goose Arm. Twenty-two collections were obtained from the north shore of Goose Arm and thirty-five from the south shore.

In 1991, thirty-six additional new horizons were sampled along Goose Arm. Fifteen of these horizons were sampled on the north shore of Goose Arm from the Penguin Cove and March Point formations, and twenty-one were obtained on the south shore from the March Point Formation (Figure 1).

The Penguin Cove Formation yielded trilobite, hyolithid and inarticulate brachiopod faunas correlative with those of the ?early Middle Cambrian *Proliostracus* Zone of the Hawke Bay Formation (Bridge Cove member) in the Canada Bay area (Knight and Boyce, 1987). This zone was previously not recognized in the Goose Arm area.

The March Point Formation yielded trilobite, hyolithid and inarticulate brachiopod faunas correlative with those of the late Middle Cambrian *Olenoides longispinus* and *Ehmaniella cloudensis* zones of the March Point Formation in the Canada Bay area (Knight and Boyce, 1987).

Along the dirt road from Old Mans Pond to Cox's Cove, thin bedded, crosslaminated and massive grainstones in the 'Upper Dolostone' member of the Petit Jardin Formation were sampled for macrofossils. As a result, a new medial Late Cambrian (Franconian Stage) *Elvinia* Zone trilobite fauna was discovered.

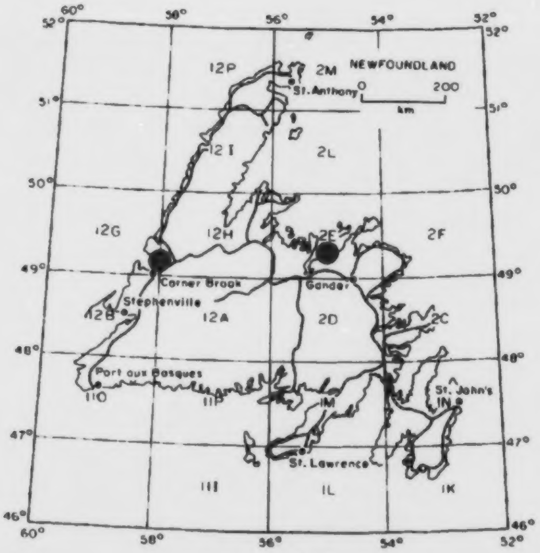

Figure 1. Map shows localities of 1991 field season.

Reluctant Head Formation

The Reluctant Head Formation is an enigmatic unit comprising thinly interbedded ribbon limestone and dolostone as well as limestone breccia/conglomerate. It may be as thick as 250 metres but is of limited areal extent (Gillespie, 1983; Williams *et al.*, 1982). In 1991, four new fossiliferous horizons were discovered within the unit. In addition, five of the sixteen 1990 localities were re-investigated (Knight and Boyce, 1991). The following species have been identified:

Trilobita
  Asaphiscus sp. cf. *A. wheeleri* Meek, 1873

---

[1] Newfoundland and Labrador Science and Technology Advisory Council, St. John's, Newfoundland.

Hemirhodon sp. cf. *H. convexifrons* Rasetti, 1946
Kormagnostus seclusus (Walcott, 1884)

The above taxa suggest that the youngest beds of the Reluctant Head Formation were deposited within the late Middle Cambrian *Bolaspidella* Zone. Consequently, the formation is probably a lateral equivalent of the 'Lower Dolostone' member of the Petit Jardin Formation exposed in Goose Arm.

Weasel Group

At the southern edge of the Lomond (NTS 12H/5) map area, Nyman *et al.* (1984, pages 158, 159, Figure 23.1) and Williams and Cawood (1989) documented a previously unrecognized sequence of thin-bedded grey limestone and buff shale, dark-grey shale and limestone (with local limestone breccia), and limestone conglomerate having a sandy limestone matrix. Nyman *et al.* (1984, page 161) proposed the name Weasel group for this sequence; the unit was interpreted to occupy a separate structural slice -- the Weasel slice -- at the base of the Humber Arm Allochthon.

Biostratigraphic sampling of the Weasel group indicates that the sequence is, for the most part, upright and youngs to the northeast. Forty-one collections were made from limestone conglomerate and shaly limestone/limy shale beds exposed along the logging road. The oldest identified faunas were collected from two limestone conglomerate beds that may be of equivalent age; trilobites indicative of the early Late Cambrian *Cedaria* and *Crepicephalus* zones (early Dresbachian Stage) were obtained. The next limestone conglomerate bed yielded taxa indicative of the early Late Cambrian *Aphelaspis* and *Dunderbergia* zones (late Dresbachian Stage). Higher still, the distinctive trilobite *Irvingella* sp. was obtained from loose, weathered blocks of planar bedded, laminated dark-grey shaly limestone/limy shale. This cosmopolitan trilobite is indicative of a medial Late Cambrian *Elvinia* Zone (early Franconian Stage) age. Higher up the column, the limestone conglomerates proved to be more dolomitic, consequently fossils were rarer. However, one boulder from the highest conglomerate sampled contained a large cephalopod cross-section, as well as some echinoderm (crinoid?) drbris, indicating a probable Ordovician age.

Humber Arm

The Halfway Point member of the allochthonous Cooks Brook formation (Northern Head group -- Humber Arm Supergroup) consists predominantly of lime conglomerates separated by interbedded parted lime grainstones and nodular to ribbon limestones (Botsford, 1988, page 58). It is approximately 120 m thick and is best exposed at Halfway Point, on the south shore of Humber Arm. In 1991, the Halfway Point member was sampled for trilobites. Fifty-four collections were obtained, chiefly from the basal conglomerates. Preliminary analysis suggests that the basal conglomerate includes clasts of *Bolaspidella* Zone age, as well as *Ehmaniella* Zone (*Bathyuriscus - Elrathina* Zone of earlier workers). Consequently, the basal conglomerate is possibly slightly younger (*Bolaspidella* Zone) than earlier believed.

A pygidium of the trilobite *Ehmaniella cloudensis* (Howell, 1943) was collected from a limestone conglomerate lens within the 'Lower Shaly Interval' of the Cooks Brook formation (*i.e.*, below the basal conglomerates). The specimen -- from matrix at the base of a small channel/scour -- is firmly indicative of a late Middle Cambrian *Ehmaniella* Zone age. This suggests that the Cooks Brook formation is probably no older than *Ehmaniella* Zone (late Middle Cambrian), and the underlying Irishtown formation is no younger than *Glossopleura* Zone (medial Middle Cambrian).

CENTRAL NEWFOUNDLAND

Bay of Exploits

At the invitation of B.H. O'Brien, Boyce and Ash rendered further paleontological assistance in the Bay of Exploits area (Figure 1). During the course of our investigations, twelve previously unrecorded fossil horizons were sampled in limestone lenses and layers in turbidite deposits exposed on Upper Black Island. The faunas obtained are dominated by articulate brachiopods, echinoderms (crinoids) and dendroid graptolites. Identification and dating of the new faunas has yet to be done. Approximately fifteen samples were also taken for future conodont analysis.

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PROVENANCE STUDIES OF AVALON - DUNNAGE ZONES

Tomasz Dec
Newfoundland Mapping Section

The results of the petrographic and microprobe provenance studies of the volcaniclastic deposits of the Love Cove and Connecting Point groups (Avalon Zone), earlier reported in Dec *et al.* (1989) and Dec (1990) have been published in the paper "Avalonian Eastport basin (Newfoundland Appalachians): Modal composition, detrital clinopyroxene geochemistry and paleotectonic implications"; co-written with S. O'Brien and I. Knight and submitted in April 1991 to Precambrian Research.

The results of provenance investigations of limestone conglomerate within the Mount Cormack Subzone, reported by Dec and Colman-Sadd (1990), have been augmented by an analysis of major-element chemistry of detrital and *insitu* chromites and encapsulated as a part of the paper "Dunnage-Gander relationships and Ordovician orogeny in Central Newfoundland: a sediment provenance and U - Pb study"; co-written with S. Colman-Sadd and G. Dunning and submitted in August 1991 to the Canadian Journal of Earth Sciences.

Most of the five-week fieldwork program in the area of Point Leamington, Notre Dame Bay (a joint four-year project with Brian O'Brien), was focussed on clast composition of the polymict Goldson Conglomerate. A 30-m-thick section from the lowest part of the mass-flow conglomerates and pebbly sandstones, exposed northeast of Randels Cove (West Arm), has been measured in detail and representative samples have been collected throughout the section. Additional sampling and reconnaissance investigations were carried out in the area of West Arm, New Bay and Osmonton Arm.

A continuous, 127-m-thick section through the main portion of Strong Island chert (O'Brien, 1990), exposed on Strong Island, has been measured in collaboration with Jim Floyd of the British Geological Survey. The study was concentrated on puzzling, compositionally diverse, volcaniclastic deposits that are interbedded with ribbon cherts and pillow lavas. These mass-flow sandstones and conglomerates contain a significant rhyodacitic and andesitic detritus. The preliminary petrographic work has also identified detrital material that may have been derived from rocks of continental crust. The provenance of volcaniclastic deposits - a possible magmatic linkage with the pillow lavas - remains enigmatic, as well as the depositional setting of the sedimentary and extrusive rocks of Strong Island chert. Addressing these problems will require an integrated sedimentological and geochemical approach.

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GEOLOGY OF THE EASTERN POND (NTS 2D/11W) MAP AREA, CENTRAL NEWFOUNDLAND

W. Lawson Dickson, P.Geo.
Newfoundland Mapping Section

The Eastern Pond (west half) map area, (formerly known as the West Gander Rivers map area), contains three main components. These are, 1) the sedimentary rocks of the Spruce Brook Formation, the Davidsville and Botwood groups and North Steady Pond Formation, 2) the Great Bend ultramafic complex and 3) the Mt. Peyton Intrusive Suite, as well as minor sedimentary and intrusive units. The geological units within the three main components are illustrated in Figure 1.

The Spruce Brook Formation comprises a polydeformed sequence of lower-greenschist facies, grey sandstone, siltstone, slate and locally prominent quartz-rich sandstone cut by abundant quartz veins. The eastern part of the sequence is contact metamorphosed by the Mt. Peyton Intrusive Suite with the progressive development of biotite, cordierite and garnet toward the contact.

The Davidsville Group (equivalent to part of the Baie d'Espoir Group) also consists of a polydeformed sequence of grey to black sandstone, siltstone and black slate. Minor pebble conglomerate and coarse sandstone contain conspicuous chert and feldspar fragments. The chert may be derived from the fossiliferous Unit 7 located west of Bear Brook. The Davidsville Group contains a prominent subhorizontal axial-planar second cleavage associated with second folds of bedding and cleavage. Graptolites in grey slate were discovered in the Webber Brook area and are tentatively taken to indicate an Ordovician age. This would correspond with similar slates located 3 km to the northeast, which contain Caradocian graptolites (Blackwood, 1981).

Five units have been tentatively assigned to the Botwood Group. The sedimentary rocks east of the Mt. Peyton Intrusive Suite form the continuation of a sequence containing corals, crinoid stems and brachiopods that "suggests" a Silurian age (Anderson and Williams, 1970). To the southwest of the Great Bend ultramafic complex, a newly discovered calcareous sandstone interbedded with cleaved sandstone and slate also contains crinoid stems, rugose corals and brachiopods. Previous workers have assigned this to the unfossiliferous North Steady Pond Formation of the Baie d'Espoir Group and assigned a Middle to Late Ordovician age to the formation (e.g., Dec and Colman-Sadd, 1990). This sequence possibly contains the same fauna as that listed by Blackwood (1981) and dated as possibly Silurian by Anderson and Williams (1970). The two sequences are therefore correlated. Detailed study of the fossils may give a precise age for the sequence. The southeastern units of the Botwood Group contain abundant evidence for shallow-water deposition. These include abundant mud-cracks, symmetric and asymmetric ripple marks, cross-laminations, cross bedding, and graded bedding. Red and green shale (Unit 12) associated with units 10 and 11 also contains rain pits.

West of the Mt. Peyton Intrusive Suite, a sequence of grey sandstone (Unit 13) is tentatively assigned to the Botwood Group. The unit consists of a monotonous sequence of grey, medium bedded laminated sandstone, containing locally developed mud-cracks, and minor slate. The sandstone beds have been deformed to form boudins. Possibly overlying this unit is an intensely cleaved sequence of red and green siltstones, breccias, sandstones, and conglomerates (Unit 14), which display parallel- and cross-laminations, scours, graded beds, rip-ups, and lenses. This sequence is similar to the Botwood Group in its type area.

West of Bear Brook, a complexly folded, black, ribbon chert and containing thin slate laminae is interpreted to be associated with the ultramafic complex. Graptolites in the slates

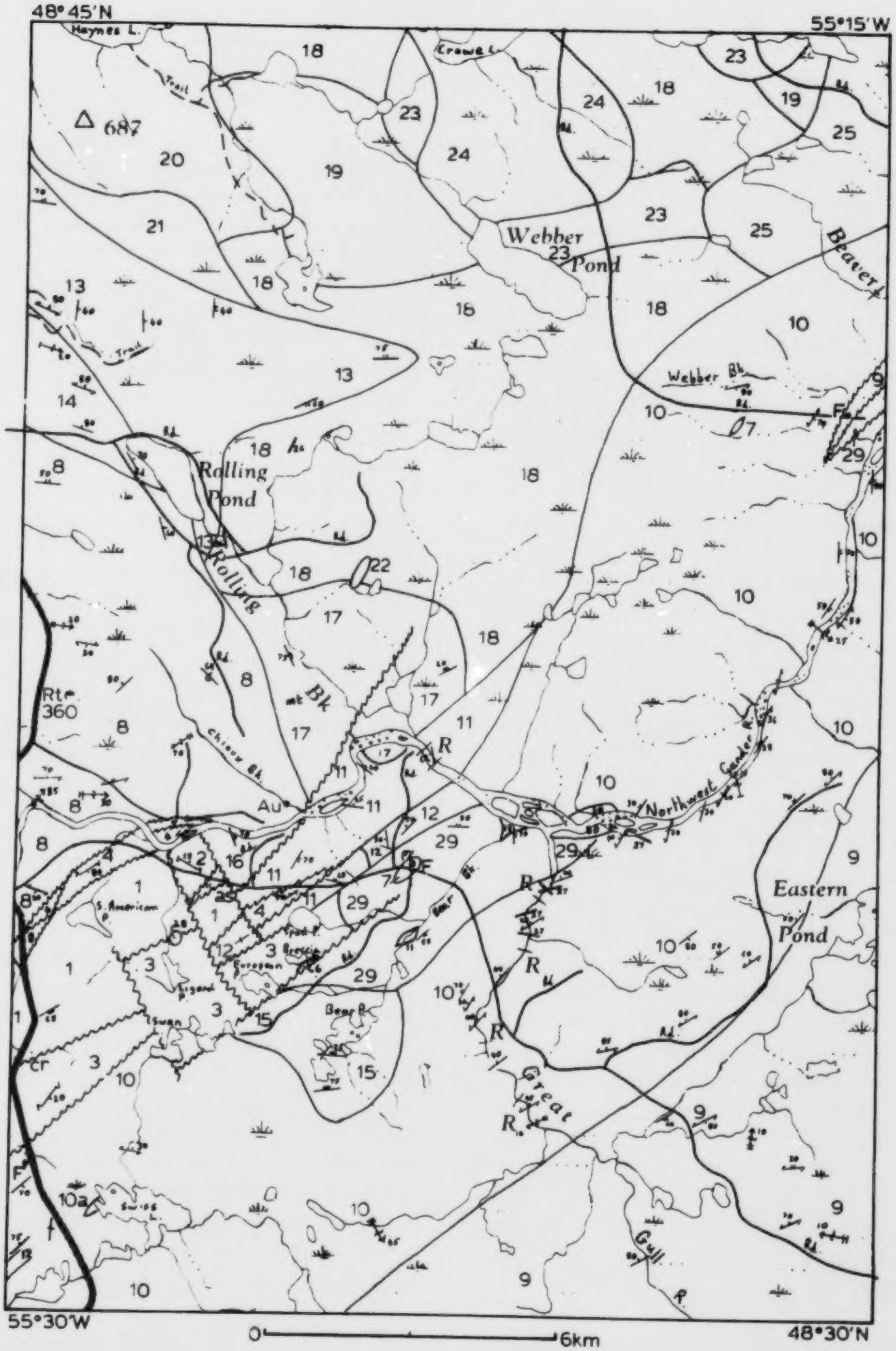
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Figure 1. Geology of the Eastern Pond (NTS 2D/11W) map area, central Newfoundland.

LEGEND

DEVONIAN or YOUNGER

30 *Very thick bedded coarse breccia with imbricated slate clasts (derived from Unit 10) and well-rounded polymict pebbles and cobbles*

29 *Very thick bedded feldspathic sandstone, pebble cobble conglomerate, red, brown and black shale; contains conspicuous chert clasts derived from Unit 7*

28 *Peridotite-cobble to -pebble conglomerate and minor peridotite-clast sandstone*

SILURIAN to DEVONIAN

27 *Fine to medium grained diabase dyke*

Mt. Peyton Intrusive Suite (Units 17 to 26)

26 *Fine to medium grained diabase dyke*

25 *Medium to fine grained, locally miarolitic, leucocratic biotite granite*

24 *Fine grained, equigranular, biotite granite*

23 *Medium grained, equigranular, hornblende–biotite granodiorite*

22 *Fine grained, equigranular, biotite–hornblende tonalite*

21 *Medium grained, equigranular, leucocratic, muscovite–biotite granite locally displaying a strong eutaxitic foliation; commonly contains xenoliths of migmatized sediment probably from Unit 13*

20 *Medium grained, hornblende–biotite gabbro*

19 *Medium grained, hornblende gabbro cut by abundant granitic dykes and veins*

18 *Medium to fine grained, hornblende gabbro; locally contains very coarse pegmatitic hornblende gabbro*

17 *Medium to coarse grained, layered to uniform, hornblende gabbro*

16 **Great Bend gabbro** *Medium to coarse grained, layered to uniform, hornblende gabbro*

15 **Bear Pond gabbro** *Coarse grained, hornblende gabbro and diabase; gabbro locally displays a weak mineral alignment*

SILURIAN

NORTH STEADY POND FORMATION AND BOTWOOD GROUP (Units 10 to 14)

14 *Thin- to thick-bedded, well-cleaved, red and green siltstone, sandstone, conglomerate and breccia*

13 *Buff-weathering, grey, mud crack-bearing, boudinaged, sandstone hornfels;* 13a, *migmatized equivalents*

12 *Red and green, weakly cleaved, siltstone and sandstone locally containing mud cracks and rain pits*

11 *Grey, mud crack-bearing, sandstone hornfels*

10 *Grey to green, well-cleaved, mud crack-bearing sandstone and siltstone, slate, coarse sandstone and pebbly sandstone, rare calcareous, fossiliferous sandstone;* 10a, *pebble conglomerate*

MIDDLE ORDOVICIAN ?

9 **Davidsville Group** *Polydeformed, greywacke sandstone, black graptolitic slate, granule conglomerate*

EARLY ORDOVICIAN ?

8 **Spruce Brook Formation** *Polydeformed, greywacke sandstone, siltstone, quartzose sandstone and slate*

7 *Black, pyritic, ribbon chert and minor graptolitic black slate*

CAMBRIAN to EARLY ORDOVICIAN ?

GREAT BEND ULTRAMAFIC COMPLEX (Units 1 to 6)

6 *Silicified, red ultramafic breccia*

5 *Chloritized basalt and schistose mafic tuff*

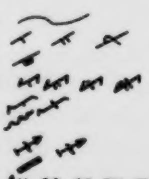
4 *Amphibolite and chloritized amphibolite schist, probably of gabbroic origin, and mylonitic serpentinite*

3 *Mainly schistose magnesite containing minor chromite layers and pods*

2 *Massive to schistose, layered dunite and harzburgite*

1 *Massive to sheared, layered to uniform, serpentinized peridotite; includes dunite and minor harzburgite*

SYMBOLS



Geological contact (not classified)..
Bedding (tops known, unknown, overturned)..
Primary igneous layering or mineral alignment..
Cleavage (first, second; inclined, vertical)..
Shear or mylonitic fabric (inclined vertical)..
Fault (not classified)..
Fold axis (first, second generation)..
Dyke..
Mineral occurrences (gold, arsenopyrite, chromite, pyrite, magnetite).. *Au, as, cr, py, mt*
Fossil locality.. *F*

suggest a Lower Ordovician age (Boyce, personal communication, 1991).

A unique, poorly bedded, peridotite-pebble to -boulder conglomerate (Unit 28) nonconformably overlies the sheared ultramafic rocks, 500 m north of Lizard Pond. This conglomerate is composed entirely of massive peridotite clasts. In the Bear Brook area, an extensive sequence of poorly bedded, coarse grained, uncleaved, feldspathic sandstone, friable red and black shale, and cobble to pebble conglomerate (Unit 29) is interpreted to overlie the Botwood Group and the cherts (Unit 7) possibly associated with the ultramafic complex. The sequence contains abundant plagioclase and chert clasts and the conglomerate contains felsic volcanic boulders. The sandstone nonconformably overlies diabase east of Bear Brook and the chert fragments are identical to Unit 7. East of the mouth of Great Gull River, along the Northwest Gander River, several outcrops consist of polymict conglomerate and breccia (Unit 30), which may overlie Unit 29. The conglomerate contains prominent, imbricated slate clasts from the nearby Botwood Group, and 10 cm well-rounded boulders of sandstone. Clasts from all nearby units, including the ultramafic complex, can be found in the conglomerate.

The Great Bend ultramafic complex comprises peridotite and locally definable dunite and harzburgite that dominate the northwestern portion of the complex, and magnesite that dominates the southeastern portion. The contact between these is intensely sheared. The northern contact of the complex with the Spruce Brook Formation is a nearly 1 km-wide band of strongly foliated, amphibolitic gabbro and mylonitic serpentinite that contains imbricated slivers of pelite probably derived from the Spruce Brook Formation. Mafic tuffs and flows (Unit 5) to the north of the amphibolitic gabbro may also be part of the complex.

The Mt. Peyton Intrusive Suite, in the study area, is a composite intrusion comprising massive, layered to uniform hornblende gabbro and hornblende - biotite gabbro. Leucocratic granite has intruded the gabbros along the northwestern and northeastern parts of the complex. Fine-grained biotite granite and granodiorite have intruded the gabbros in the Webber Pond area with extensive areas of gabbro invaded by granitic dykes. Layered gabbro is well developed along Rolling Brook and is lithologically identical to the Great Bend gabbro adjacent to the ultramafic rocks along the Northwest Gander River. In the Bear Pond area, the coarse gabbro with a poor mineral alignment and associated diabase is a possible correlative of the other layered gabbros. In the northern part of the map area, medium grained hornblende gabbro is dominant. In the area around Haynes Lake, biotite - hornblende gabbro has intruded (Unit 13) of the Botwood Group. The sediments are migmatized adjacent to the contact and an area of sedimentary xenolith-rich granite occurs between the hornblende - biotite gabbro and the sediments. It is likely that the granite is derived from the Botwood Group. In the north-central and eastern parts of the map area, the gabbro is intruded by a variety of granodioritic and granitic rocks.

The ultramafic rocks appear to have the greatest mineral potential with well known chromite and magnesite occurrences. The ultramafic rocks, in particular the magnesite, have been extensively examined for gold including drilling, trenching, geophysical surveys, and geochemistry. A trench, 3 km northeast of South American Pond, contains massive sulphide (possibly arsenopyrite) veins in sheared serpentinite. Black slate intruded by diabase at Chioux Brook contains significant gold values (various open company assessment reports). Extensive rusty alteration and magnetite veins occur within the Mt. Peyton gabbros, west of Rolling Brook.

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THE STRUCTURAL EVOLUTION OF THE EASTERN MARGIN OF THE CENTRAL APPALACHIAN MOBILE BELT, NEWFOUNDLAND

R.E. Holdsworth[1], S.J. O'Brien[2] and P.P. O'Neill[2]

This project is a regional, structural-based study of the geological evolution of the Gander-Avalon zone contact, a feature normally considered to represent a major Paleozoic terrane boundary. The study, which was initiated in 1990, is closely integrated with ongoing regional mapping projects in both the Gander (O'Neill, *this volume*) and Avalon zones (O'Brien and Holdsworth, *this volume*). It is an attempt to link the geological histories of the Gander and Avalon blocks to the kinematic history recorded along the terrane-bounding Dover Fault.

Detailed structural mapping was carried out over a period of one month in the 1991 field season. Mapping of the Gander - Avalon boundary in the Glovertown (NTS 2D/9) map area was undertaken in conjunction with 1:50,000 mapping in this area. In addition, mapping of a narrow corridor across the Gander Zone from a point near the Dover Fault at Centreville, westwards to the Wing Pond Shear Zone was completed earlier (O'Neill, 1991a) (Figure 1).

The reactivated, transpressional deformation history recognized along the Dover fault zone north of this area (Holdsworth, 1991) is also observed along the Gander - Avalon boundary throughout the Glovertown map area. A broad zone of early ductile sinistral transpression in both Avalon and Gander zones is overprinted by lower grade ductile and then brittle dextral displacements. In the eastern part of the Gander Zone, widespread granitic magmatism and high-grade metamorphism are associated with the early ductile sinistral movements.

In the northern half of the Glovertown map area, an almost complete section of later ductile dextral mylonites is preserved. In areas studied farther north (Holdsworth, 1991), this sequence was extensively disrupted by brittle dextral faults. In contrast, a single brittle dextral fault has cut out all of the late ductile mylonites in the southern part of the sheet. Thus the structure shown as the 'Dover Fault' in previous maps is in fact a ductile dextral fault in the north and a later brittle structure in the south.

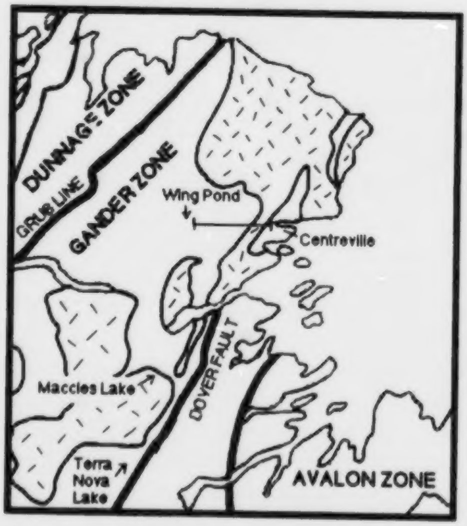

Figure 1. Study area.

Field observation along the Wing Pond - Centreville corridor demonstrates that displacements along the Gander - Avalon boundary can be related to the structural history of the Gander Zone. Early sinistral ductile displacements along the boundary appear to have occurred synchronously with the regionally recognized F_3 event (O'Neill, 1991b); thus, they also occurred synchronously with displacements associated with the Wing Pond Shear Zone. Preliminary studies suggest that movements along the Wing Pond Shear Zone are predominantly dip-slip pure shear. This implies that strain partitioning of dip-slip and strike-slip movements occurred during F_3 sinistral transpression.

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The Gander - Avalon boundary shear zone and the Wing Pond Shear Zone are both foci for belts of high-grade regional metamorphism and associated syntectonic magmatism. Earlier displacements within the Gander Zone appear to be roughly orogen parallel, involving generally north to south overthrusting at low- to moderate-metamorphic grades. These displacements are not recorded within the Avalon Zone.

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COLLECTION, INTEGRATION AND INTERPRETATION OF GEOCHEMICAL DATA FROM GRANITOID ROCKS OF INSULAR NEWFOUNDLAND: ACTIVITIES DURING 1990

Andrew Kerr and John P. Hayes
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PROJECT OVERVIEW

This project was established to compile, integrate and release geochemical data collected by the Geological Survey Branch from granitoid plutonic rocks throughout insular Newfoundland, and to expand and complete this database using a program of field work. A parallel objective is to develop and participate in multidisciplinary projects aimed at developing a better understanding of the petrogenesis and mineral potential of these suites in the wider framework of Appalachian evolution.

Activities during 1991 included the following:

1. Correction and verification of existing data to eliminate problems dating from original data entry and preceding compilation steps.

2. Updating of sections of the database by replacing analyses conducted during the early 1970's with new analyses of the original sample material.

3. Initiation of compilation of analytical precision and accuracy data for data from various years.

4. Initiation of a comprehensive field program aimed at extending and completing coverage, and providing material for multidisciplinary research studies. This builds upon initial work conducted during the 1989 and 1990 field seasons.

CORRECTION AND VERIFICATION OF EXISTING DATABASE

Kerr *et al.* (1991) provided a review of the sources of existing geochemical data from Newfoundland granitoid rocks, and discussed some of the problems that need to be resolved prior to data release. These include verification of pluton and/or unit classifications to reflect the most current geological maps, and the removal of various unrelated data (e.g., country rocks, younger diabase dykes) that had inadvertently been included with granitoid rocks in the original data files.

This procedure was initiated in late 1990, and was almost complete by April 1991. This work was combined with modifications to the database format to accomodate future classification and/or interpretation needs. The main remaining task is one of subdivision: A number of divisions within the database (e.g., Burgeo Intrusive Suite) are composite units of considerable complexity, and subunits defined during mapping need to be introduced.

UPDATING OF DATABASE WITH NEW ANALYSES

As discussed by Kerr *et al.* (1991), reanalysis of a random subset of samples from the Strong *et al.* (1974) project, raised some concerns about the reliability of some of the geochemical data from this project, which is an important contributor to the database in eastern Newfoundland.

Accordingly, all of the samples from the 1974 database were completely reanalyzed; this work was mostly completed by the end of 1990. In addition to eliminating concerns about earlier analyses, this provides a wide range of trace-element data (e.g., Li, Be, Ga, Y, Nb, Mo, La, Ce) that were not determined during the original survey.

During the database correction/ verification procedure outlined above, the geochemical data for samples from the 1974 survey were replaced with the new analyses. This work is now complete, and it removes the last significant obstacle to open-file release of the existing data. No date will, however, be set for release, until the subdivision of large blocks of data from composite suites (see above) is completed.

There is certainly a need for further reanalysis of some older sample populations. In some cases (e.g., DeGrace *et al.*, 1976), the original materials cannot be located, and these areas will thus have to be resampled (at least in part). In southern Newfoundland, the data from the Baie D'Espoir area is lacking a number of crucial trace elements (e.g., Y, La, Ce and Th), and selective or complete reanalysis is warranted for these. This will be initiated in late 1991.

COMPILATION OF PRECISION AND ACCURACY DATA

Existing data were collected over a period of 15 or more years, sometimes via different institutions. Thus, detection limits, accuracy and analytical precision have probably varied. All analytical duplicates were removed from the database during the correction process. An attempt will now be made to calculate estimates of analytical precision and accuracy on a year-by-year basis. In combination with the 'YEAR of ANALYSIS' variable in the new database format, this will aid in comparison of data from different projects and pinpoint any further reanalysis requirements for older data. This work is being conducted by the second author, and will also involve geochemical data from other projects not directly related to the granitoid database. It is therefore a long-term project anticipated to extend well into 1992.

FIELD WORK DURING 1991

Although large amounts of data have been acquired by the Geological Survey Branch from granitoid rocks, the coverage is presently far from representative. There is a clear need for a field program to expand the database to include areas that are unrepresented or poorly represented. Limited field work has previously been conducted as part of this project during the 1989 and 1990 field seasons (Kerr, 1989, 1990), and a comprehensive, systematic field program was initiated during 1991, for a period of approximately 10 weeks.

During 1991, the main foci of field work were the intrusive rocks of the Dunnage Zone in central and west-central Newfoundland, which are presently very poorly represented in the database. Areas that were covered in 1991 include granitoid rocks of the Baie Verte Peninsula, the Skull Hill Syenite, the Hodges Hill - Twin Lakes intrusive complex, the Long Island and Loon Bay plutons, the diorite - granite complex of Fogo Island, and a number of smaller intrusions in the Notre Dame Bay - Green Bay area (Figure 1). Field work consisted of lithological mapping and geochemical sampling and, for the most part, was focussed in areas of relatively easy access, such as public and forest access roads, and coastal areas in Notre Dame Bay. A limited amount of work was also conducted with helicopter support in areas of difficult access. All of these areas were previously unrepresented in the database.

In addition to the systematic sampling described above, field work was also conducted in a number of widely dispersed areas in conjunction with a LITHOPROBE-supported project to examine the isotopic systematics of granites across Newfoundland. This work consisted of lithological description, and sampling for eventual Nd-Sr-O isotopic analysis by B.J.Fryer and coworkers. Areas visited included the Hare Hill and Hughes Lake intrusions (western Newfoundland), parts of the Topsails Complex (central Newfoundland), probable late Precambrian intrusive rocks in central Newfoundland, and a number of Precambrian and Paleozoic intrusions within the Avalon Zone. The latter include the Holyrood granite, Swift Current Granite, Powderhorn diorite complex, Cross Hills Plutonic Suite, St. Lawrence Granite and mafic sills in the Cape St.Mary's area. Most of these areas are located in Figure 1. In some of these areas, limited systematic sampling was also conducted to provide or improve coverage in the granitoid database.

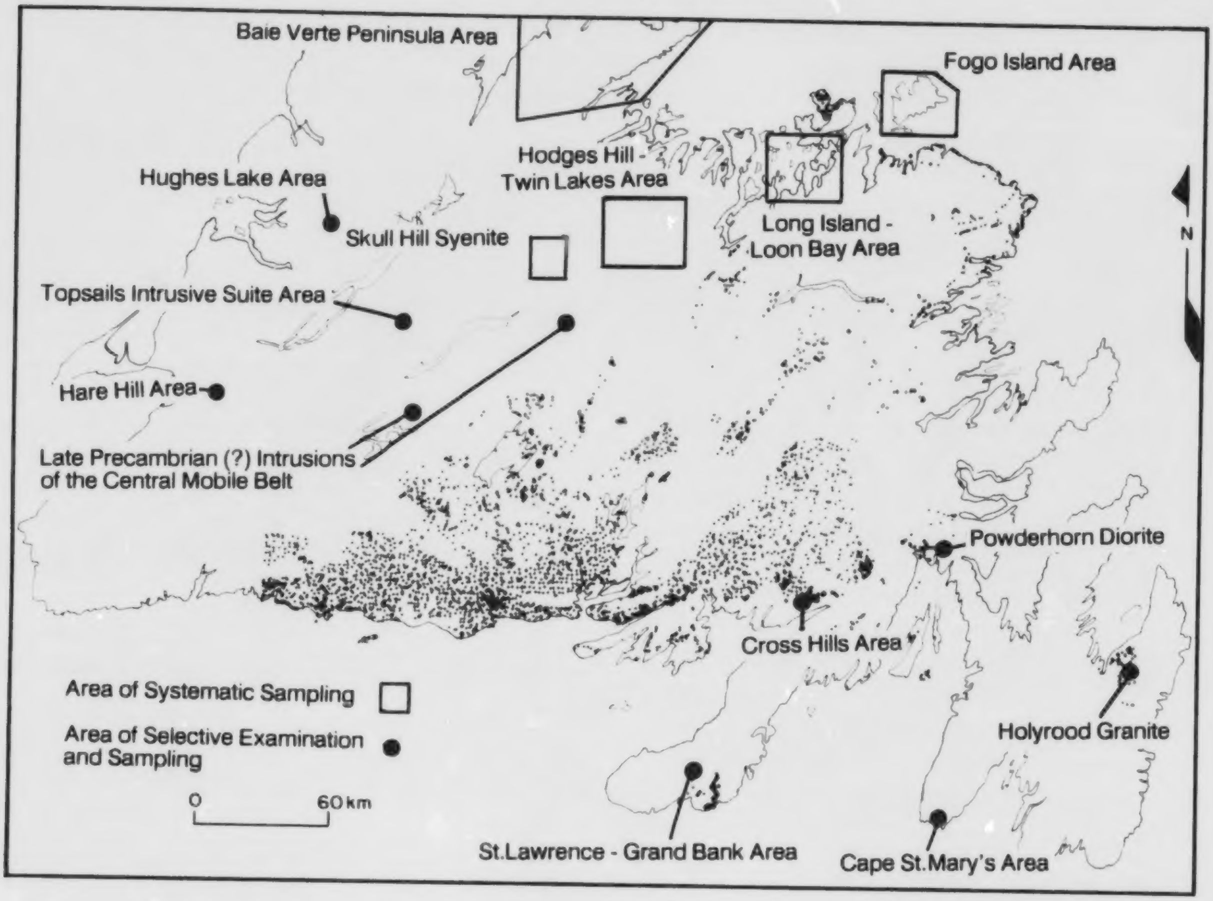
Baie Verte Peninsula Area
Fogo Island Area
Hodges Hill - Twin Lakes Area
Hughes Lake Area
Skull Hill Syenite
Long Island - Loon Bay Area
N
Topsails Intrusive Suite Area
Hare Hill Area
Late Precambrian (?) Intrusions of the Central Mobile Belt
Powderhorn Diorite
Cross Hills Area
Area of Systematic Sampling ☐
Area of Selective Examination and Sampling ●
0
60km
Holyrood Granite
St.Lawrence - Grand Bank Area
Cape St.Mary's Area

Figure 1. **Summary map showing the general locations of areas in which field work was conducted during the 1991 field season. The small crosses show the locations of samples already within the granitoid database.**

As a subsiduary project, a B.Sc. honours thesis project has been initiated to examine the petrology, geochemistry and geochronology of the Iona Islands intrusions in eastern Placentia Bay. These are considered to be the most easterly examples of middle Paleozoic plutonism in Newfoundland, although their age has never been established. A description of this project is provided by Peckham (*this volume*); it will hopefully be completed by the Spring of 1992.

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MARBLE, FOSSILS AND TROUBLING CARBONATES, DEER LAKE - GOOSE ARM AREA

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Variously metamorphosed, Cambro-Ordovician platformal carbonate rocks underlie much of the Pasadena Map area. In the Deer Lake and Goose Arm areas, the succession is assembled in several thrust sheets with increasing metamorphism and deformation from west to east. Within the most easterly thrusts are marble with good economic potential.

DEER LAKE

Detailed mapping of a 300-m-high ridge of good quality marble was undertaken to the northwest of Deer Lake. The northeast-trending ridge is underlain by a poly-deformed marble succession. The structure comprises a duplex that is folded about a northeast-plunging anticline and syncline. Complex small-scale structures indicate that D_1 thrusts are northwestward verging. The northeast trending folds are second phase structures that are associated with northwestward dipping cleavage and locally southeastward recumbent limbs. Boomerang-shaped interference fold patterns are locally developed where D_1 and D_2 structures intersect. Pervasive C-S fabrics, associated with northwest dipping fractures, indicate a late phase of downdip extension. The three main deformations reflect the interaction of the platform with the emplacement of and deformation with the Old Man Pond allochthon. Initially, this involved northwestward overthrusting of the allochthon, followed by a later southeastward-verging compressional event, which culminated with the juxtaposition of the allochthon against the marble, during a late phase of extension. All indicators suggest that the allochthon was always structurally above the platform and not vice versa. Locally, kink bands affect D_2 structures. D_1 to D_3 structures predate the Visean because caves with Carboniferous speleothems and sediments are common along faults within the marble and at the allochthon - marble structural contact. Locally, late- or post-Carboniferous reactivation of faults has deformed the cave deposits.

The succession in the area consists, in ascending order, of a lower psammitic pelite; a ribbon limestone - phyllite unit equivalent of the Reluctant Head Formation, a massive dolomite marble unit, locally with chert, a white to grey lime marble and lesser dolomite marble, and an upper phyllitic unit having carbonate breccias and limestone beds. Detailed study indicates that the stratigraphy within the dolomite and lime marble is closely comparable with the less-deformed carbonate sequence found elsewhere in western Newfoundland.

The marble in the area are typically fine to medium grained, with good hardness and strongly massive. They comprise white to grey varieties that include Arabescato (originally conglomerate), Venato, Nuvolato, Crema and Bardiglio. The latter has an interesting stylolitic fabric. Some pink zones also occur in the deposits possibly associated with Carboniferous colouration of the marble close to faults. The economic potential of the marble is presently being assessed and substantial tonnage is probable in several stratigraphic intervals that are repeated by the thrusting.

GOOSE ARM

Studies in this area continue from 1990. Mapping indicates that there are several thrusts associated with recumbent folds and west-verging C-S fabrics. These D_1 structures are folded by northeast-trending D_2 fold structures. The succession outlined by Knight and Boyce (1991) differs very little in stratigraphic detail from that in the Deer Lake area but is of lower metamorphic grade. The stratigraphic picture, however, becomes blurred toward the top of the succession, where cleaved, are intercalated with carbonates including breccias, deformed by recumbent folds and locally incorporated in melange. In addition, there are a number of lithologically and stratigraphically interesting transported sequences that lie immediately beneath the main basal melange of the Humber Arm Allochthon and above parautochthonous carbonates.

The first of these is a mountain of steeply vertically dipping, westward younging, white limestone that occurs just north of Penguin Arm. The limestones comprise massive, mottled and fenestral laminated types that may be Middle Ordovician. They may be the source of exotic white limestone clasts, which occur in carbonate conglomerates, that occur in Middle Ordovician flysch elsewhere in western Newfoundland.

The second sequence of interest is the Weasel group, a unit of carbonate conglomerate, ribbon limestone and phyllite that was delineated by Nyman and others (1984) and Williams and Cawood (1989) at the northern edge of the Pasadena map sheet. Trilobites from the conglomerates indicate it spans Dresbachian (Late Cambrian) to ?Early Ordovician time. The ribbon limestones and conglomerates are lithologically similar to the Reluctant Head Formation and unlike the periplatform lithofacies of the Cooks Brook Formation and Cow Head Group. The formation is unlikely to be older than *Cedaria-Crepicephalus* Zone in age unlike the type Reluctant Head Formation which is *Bolaspidella* Zone and older. Carbonate conglomerates dominate Dresbachian, post-*Elvinia* and Ordovician parts of the succession. A thick section of shale and calcareous argillite overlying Dresbachian conglomerates hosts a Franconian *Elvinia* Zone fauna. Above this shaly interval, the conglomerates include a pre-Ordovician section that is extensively dolomitized and includes an interval rich in rounded quartz sand grains. The Reluctant Head Formation and Weasel group appear to confirm that the part of the Cambrian shelf margin from which they were structurally transported was a prograding ramp until the Dresbachian before sea level rise drowned the margin during the *Elvinia* Zone. Renewed progradation through the late Cambrian and Ordovician occurred along a distally steepened margin.

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ON SOME RELATIONSHIPS BETWEEN EARLY AND LATE ORDOVICIAN ROCKS OF THE EXPLOITS SUBZONE IN CENTRAL NOTRE DAME BAY (NTS 2E/5,6), NEWFOUNDLAND

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During the 1991 field season, geological mapping in central Notre Dame Bay was carried out in two separate regions to facilitate comparison of stratigraphic and structural relations between early and late Ordovician map units in different parts of the Exploits Subzone. The Western Arm Brook - Leading Tickles region between Seal Bay and New Bay (Figure 1) was examined with the aim of establishing the internal and external relationships of the oldest (northern) part of the South Lake Igneous Complex, the upper (eastern) part of the Wild Bight Group and the lower (western) part of the Point Leamington Formation. The Winter Tickle - Hornet Island and Laurenceton - Stanhope areas in the Bay of Exploits region were studied first, to ascertain the disposition of the upper units of each of the Exploits Group, the Samson Greywacke and the Point Leamington Greywacke. And secondly, attempts were made to discern their relationships with the Boones Point Complex, the Dunnage Melange, the lower units of the Exploits Group and either the marine or terrestrial sequences of the Botwood Group.

Early to middle Ordovician rocks comprise the Exploits Group, the Wild Bight Group and the South Lake Igneous Complex. The oldest exposed formation of the Exploits Group is an ensimatic succession of mafic pillow lavas comprised of both rift-related and subduction-related rocks (cf. Swinden *et al.*, 1990); the latter are associated with contemporaneous felsic pyroclastics and volcanogenic sulphide mineralization. The rift-related rocks are interstratified with graptolite-bearing hemipelagic chert and conodont-bearing limestone that indicate a Llanvirn age for this type of mafic volcanism. Where a siliclastic flysch (up to 3 km thick) separates the rift- and subduction-related pillow lavas, the latter are demonstrably older. Precisely how much older is unclear as the brachiopods and graptolites recovered from the intervening flysch are not useful as biostratigraphic markers. In the western part of the Exploits Group, where this flysch is absent or anomalously thin, rift- and subduction-related rocks occur in a contiguous section composed completely of pillow lavas with numerous base-metal showings.

Sedimentary rocks of the Wild Bight Group are separable into formations that are represented by either thin-bedded hemipelagic chert and siliceous argillite or thick-bedded tuffaceous wackes and epiclastics. The youngest Wild Bight cherts yield Llandeilo - Caradoc graptolites; a stratigraphically underlying unit of wackes and epiclastics contains corals that are as yet undated. Regionally mappable formations dominated by either chert or wacke are interpreted to have structurally modified, primary pinch-out relationships and, therefore, are thought to be, at least in part, lateral facies equivalents within the mid-upper Wild Bight Group (Figure 1). In section, chert and wacke are interbedded in sharply gradational contact zones, which are most notable in areas where regional pinch-out of formations occurs. A thick conglomerate subunit containing granite and limestone clasts is locally developed where pillow lava, felsic pyroclastic, chert and wacke formations are relatively thin and in close proximity to each other.

Mafic pillow lavas in the Wild Bight Group have been reported to display geochemical signatures indicative of rift- and subduction-related magmatism (Swinden *et al.*, 1990) and are generally similar to those in the Exploits Group. Rift-related mafic volcanics stratigraphically underlie a Wild Bight chert formation that is, in part, Llandeilo - Caradoc in age. However, along strike in the vicinity of the Lockport base-metal prospect, the same chert formation overlies a succession of subduction-related pillow lavas.

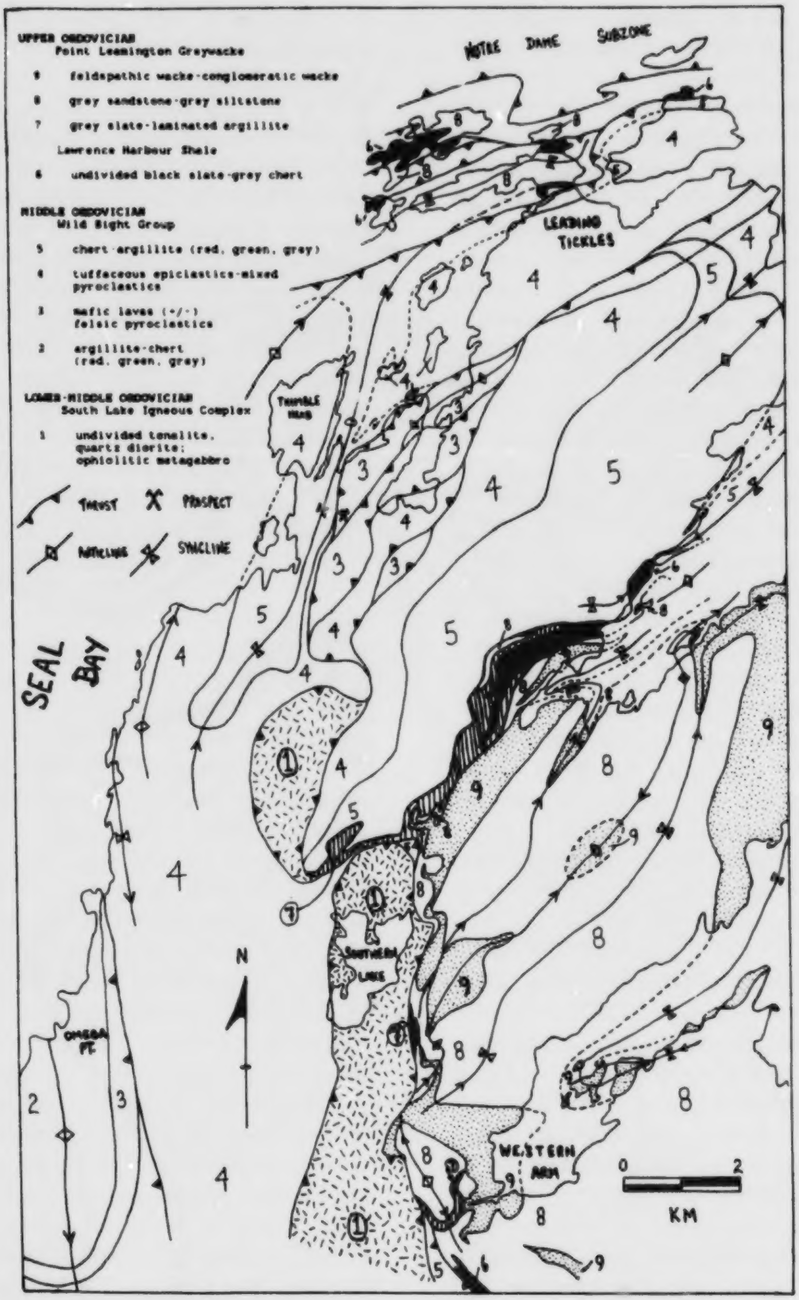
UPPER ORDOVICIAN
Point Leamington Greywacke
9 feldspathic wacke-conglomeratic wacke
8 grey sandstone-grey siltstone
7 grey slate-laminated argillite
Lawrence Harbour Shale
6 undivided black slate-grey chert
MIDDLE ORDOVICIAN
Wild Bight Group
5 chert-argillite (red, green, grey)
4 tuffaceous epiclastics-mixed pyroclastics
3 mafic lavas (+/-) felsic pyroclastics
2 argillite-chert (red, green, grey)
LOWER-MIDDLE ORDOVICIAN
South Lake Igneous Complex
1 undivided tonalite, quartz diorite; ophiolitic metagabbro
THRUST
PROSPECT
ANTICLINE
SYNCLINE
NOTRE DAME SUBZONE
LEADING TICKLES
TRIMBLE HEAD
SEAL BAY
SOUTHERN LAKE
OMEGA PT.
WESTERN ARM
N
0
2
KM

Figure 1. Simplified geological map of the Western Arm Brook - Leading Tickles region.

A regionally extensive wacke-dominated formation pinching out within and underlying Llandeillo - Caradoc and older cherts is also mapped as a wedge or split within the cherts above the mineralized subduction-related mafic volcanics. This may suggest that, in the subsurface of the Wild Bight Group, the oldest exposed formation of tuffaceous wackes and epiclastics sits above a pillow lava sequence comprised of both rift- and subduction-related rocks.

The South Lake Igneous Complex crops out in a thrust-bounded anticlinorium that also exposes, along plunge, the subduction-related, Wild Bight mafic volcanic sequence near the Lockport prospect. Within the complex, a north-trending sheet intrusion of quartz diorite crosscuts a northwest-trending mafic dyke swarm hosted by variably sheared and mylonitized, ophiolitic metagabbro. North to northwest-trending bodies of inhomogeneously deformed, blue quartz-bearing tonalite intrude the ophiolitic metagabbro parallel to its internal system of dyke swarm-related shear zones; the tonalites have unknown relations with the quartz diorite. Near its intrusive margins, the blue quartz-bearing tonalite becomes strongly foliated and, along some of its contacts with older bodies of hornblende diorite, contains concordant zones of distorted cognate xenoliths and younger swarms of variably foliated mafic dykes. The ductile deformation and mafic dyking episodes observed in the igneous complex are bracketed by its various components. This mesozonal type of synplutonic tectonism was confined to the South Lake Igneous Complex and is dated by the ages of the ophiolitic metagabbro and later dioritic and tonalitic plutons.

Upper Ordovician rocks are represented by the Lawrence Harbour Shale, the Point Leamington Greywacke, the Samson Greywacke, the Goldson Conglomerate, and the marine succession in the Botwood Group. The Lawrence Harbour Shale is a regionally mappable lithostratigraphic unit of formational or group status composed of several lithologically distinct subunits. In the fjord north of Western Arm (Figure 1), Lawrence Harbour black slate (above the basal grey chert) ranges in age from the *Diplograptus multidens* to *Dicranograptus clingani* graptolite biozones of the Caradoc. The *Nemagraptus gracilis* biozone (basal Caradoc) ranges stratigraphically downwards as low as the Wild Bight Group. The anoxic black slate of the Lawrence Harbour Shale passes laterally into and regionally interfingers with a more oxidized, grey slate and argillite subunit in the Point Leamington Greywacke, which is locally in gradational contact with the Wild Bight Group. Where this phenomenon occurs, greybeds and blackbeds are interbedded in individual sections (e.g., Williams, 1991). Where these Upper Ordovician strata lie adjacent to the South Lake Igneous Complex, grey slate and argillite are underlain and overlain by the typical grey sandstone-grey siltstone facies of the Point Leamington Greywacke (Figure 1). Grits near the South Lake Igneous Complex - Point Leamington Greywacke contact appear to be derived, in part, from erosion of blue quartz-bearing tonalite. At this locality and stratigraphic position, the Point Leamington grey slate facies most probably belongs to the *Dicranograptus clingani* biozone (mid-upper Caradoc). Whereas Point Leamington greybeds in the Western Arm Brook - Leading Tickles region range in age throughout the lower-mid Ashgill, the Lawrence Harbour Shale is nowhere known to be younger than the uppermost Caradoc - lowermost Ashgill (*Pleurographus linearis* biozone).

Characteristically, the lower part of the Point Leamington Greywacke comprises thin- to medium-bedded, lutaceous and arenaceous strata, which host debris flows that had scoured into and sampled immediately underlying Caradocian and older strata. In both the Bay of Exploits and New Bay - Seal Bay areas, this siliciclastic flysch is interpreted to infill Ashgillian fault-bounded basins developed above a hemipelagic to pelagic substrate. This iron formation and mudstone substrate is represented by a conformable succession of Llanvirn - Llandeilo Strong Island Chert and Caradocian Lawrence Harbour Shale. Although the Point Leamington Greywacke stratigraphically overlies the Wild Bight Group, it does not represent the oldest overstep succession or successor basin sequence in central Notre Dame Bay. Rather, the Middle-Upper Ordovician Strong Island Chert and Lawrence Harbour Shale together form an overstep sequence onlapping various formations in the Exploits and Wild Bight groups. Thus, ensimatic medial Ordovician volcanosedimentary units were tectonically linked prior to the Late Ordovician, which was apparently a time period in which renewed movements took place along old fault scarps in Lower-Middle Ordovician rocks.

On the Fortune Harbour peninsula and eastward on islands in the Bay of Exploits, the upper parts of the Point Leamington Greywacke and Samson Greywacke are typically composed of thick-bedded, arenaceous and rudaceous strata that are affected by large scale slump folds with contemporaneously injected sandstone dykes. At this stratigraphic position in the Ashgillian succession, the slump sheets are exclusively derived from coeval flysch, which includes uncommon argillaceous beds near slump-folded horizons. The upper parts of the Point Leamington Greywacke and the Samson Greywacke are the youngest beds that are observed to be mylonitized in the Red Indian Line structural zone. Therefore, these parts of the Ashgillian succession are commonly isolated in thrust sheets imbricated with the upper Exploits Group and the upper Cottrells Cove Group (Notre Dame Subzone). Although they occur in a different thrust sheet than the olistostrome-bearing, limy and cherty flysch typical of the marine sequence in the Botwood Group, the siliciclastic component of the Ashgill - Llandovery Botwood succession is similar to the arenaceous and rudaceous strata in the upper part of the Point Leamington Greywacke.

The Goldson Conglomerate includes distinctive units of feldspathic wacke and grit as well as pebble to cobble wackestone and graded polymictic conglomerate. The thickest and most regionally extensive units overlie the upper parts of both the Point Leamington Greywacke and the Samson Greywacke. In the vicinity of Western Arm, several irregularly-shaped, discontinuous bodies of Goldson Conglomerate occur in the lower part of the Point Leamington Greywacke; however, progressively larger, more laterally continuous, Goldson lenticules are located in stratigraphically higher positions (Unit 9 in Figure 1). The temporal range of the Goldson lithofacies, calculated using the ages of Point Leamington Greywacke units that underlie and overlie each body of Goldson Conglomerate, confirms the regional concept that Goldson deposition followed that of Point Leamington but it also indicates that conglomeratic infill overlapped most of the period of accumulation of the host greywacke. The oldest body of grit and conglomerate is post-*Dicranographus clingani*, pre-*Dicellographus complanatus* (uppermost Caradoc), while the youngest constrained lenticule is syn-*Paraorthographus pacificus* subzone of the *Dicellographus anceps* biozone (mid-Ashgill) in age.

Near the western margin of the Upper Ordovician Point Leamington basin, the stratigraphically highest lenticule of Goldson Conglomerate occurs in close proximity to the stratigraphically lowest lenticule. In contrast, a considerable thickness of sediment (largely greywacke) separates these same bodies in the centre of the basin. Until it can be demonstrated that the Goldson deposits onlap or offlap the Point Leamington deposits, it is unknown whether the depocentre deepened axially but remained stationary relative to a continuously uplifted source area or whether the depocentre moved toward or away from the original margins of the basin with time.

The marine portion of the Botwood Group includes Ashgill - Llandovery hemipelagic chert with resedimented and coeval limestone in the Bay of Exploits, and Llandovery - Wenlock sublittoral marl and pebble conglomerate in the estuary of the Exploits River. They have no known relationships with each other. The older deep-marine sequence overlies the Lawrence Harbour Shale with erosional disconformity. The younger shallow-marine sequence appears to lie adjacent to the undated scoraceous basalts of the Laurenceton Formation, which is the oldest terrestrial unit in the Botwood Group. The overlying redbeds of the Wigwam Formation of the Botwood Group, which are unfossiliferous, are bounded from rocks as young as the Point Leamington Greywacke by a regional, late-stage, transcurrent fault (Northern Arm Fault). This fault displaces an earlier ductile overthrust zone, which is the more fundamental boundary of the terrestrial portion of the Botwood Group. Interbedded, green and red sandstones stratigraphically underlying the lowest of the

Laurenceton basalts are thrust northwards over the lower part of the Exploits Group south of Stanhope. The fault zone is intruded by variably sheared and altered, gabbro-diorite sheet intrusions that locally contain gold mineralization and give an upper age limit for the terrestrial portion of the Botwood Group.

An imbricate splay of this mineralized fault zone bounds the Dunnage Melange, which is separated from the deep-marine Botwood succession by a thin thrust sheet containing the upper part of the Exploits Group. The Dunnage Melange lies structurally above the upper Exploits Group on Upper Black Island and structurally below this group on the mainland near Stanhope. A distinctive subunit of conglomeratic wacke, chert and siliceous argillite in the New Bay Formation (mid-upper Exploits Group) occurs stratigraphically below rift-related Lawrence Head pillow lavas and the Strong Island Chert. Thick graded conglomerate horizons containing clasts of fossiliferous limestone and granite are similar to those in the Wild Bight Group. Southeastward across the Exploits Group, from New Bay to Stanhope, this subunit maintains an approximately constant thickness with the possible exception of the Winter Tickle - Lawrence Harbour area, where it is anomalously widespread. Unbroken New Bay Formation and, in places, the succeeding pillow lava formation lie tectonically adjacent to the Dunnage Melange. The unbroken coticule-bearing formations that separate the block-in-matrix rocks in the Dunnage Melange in relatively untectonized parts of this map unit are dissimilar to any Llanvirn strata in the Exploits Group. It is possible that they were original facies equivalents of overlapping age, which now occur in separate, regional thrust sheets. Alternatively, they may be of different ages and completely unrelated to one another.

The Boones Point Complex comprises block-in-matrix melange, which also lies tectonically adjacent to rift-related pillow lavas of the uppermost Exploits Group. It is a minor constituent of the 3 km wide mylonite belt that demarcates the Red Indian Line structural zone, a regional south-dipping feature responsible for placing the Exploits Subzone northward over the Notre Dame Subzone. Variably straightened and mylonitized, metasedimentary and metavolcanic rocks from the Moores Cove and Fortune Harbour formations (Notre Dame Subzone) and Samson Greywacke (Exploits Subzone) pass gradationally into tectonic melange. Within the Red Indian Line structural zone, a small proportion of both early and late Ordovician flysch sequences are composed of debris flows and large slump sheets. In two localities, the protolith of the block-in-matrix melange is recognizable as a sandy to pebbly facies of siliciclastic turbidite that, in nearby low strain areas, is in stratigraphic contact with a debris flow.

In summary, an episode of medial Ordovician tectonism was responsible for excumation of a mesozonal tonalite terrain, which was emplaced through shear zones in early Ordovician ophiolite. It may have also caused syndepositional uplift of Llanvirn and older pillow lavas of ensimatic origin. In the late Ordovician, tectonic activity resulted in renewed uplift of old source areas, documented and witnessed by the biostratigraphic record of both a conglomeratic and a sandy flysch. Subsequent to the mid-Llandovery and largely prior to the intrusion of an extensive gabbro-diorite suite, these early and late Ordovician units were regionally deformed as the Exploits Subzone ductilely overthrust the Notre Dame Subzone.

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GEOLOGY OF THE BAY DU NORD GROUP BETWEEN EAST BAY AND THE LA POILE RIVER (NTS 11O/16), WESTERN HERMITAGE FLEXURE, NEWFOUNDLAND

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An integrated program of geological mapping and precise U - Pb geochronological studies (R.D. Tucker, Royal Ontario Museum, (ROM)) of the stratified and plutonic rocks north of the Bay d'Est Fault Zone in the southwestern Hermitage Flexure was initiated, during the 1991 field season. This work is an extension of recently completed regional mapping and affiliated structural, stratigraphic and geochronologic studies of the La Poile Group and adjacent rocks south of this major fault structure. Preliminary reconnoitring by the authors in the Baggs Hill area, supported by U - Pb geochronology by R.D. Tucker (ROM), enabled us to focus directly on this part of the Bay du Nord belt, which is important from the perspective of not only regional geology but also the broad tectonic setting of base-metal mineralization in this part of the Hermitage Flexure. Field investigations in 1991 were restricted to two weeks of mapping and sampling.

The area surveyed encompasses part of what is considered to be the type area of the Bay du Nord Group (Chorlton, 1980) and is bounded to the north and south by dated Silurian rocks (Figure 1). Aside from a discontinuous tract of metagabbros, all igneous and sedimentary rocks in the area had previously been viewed as part of this single lithostratigraphic unit of mid-Ordovician age (Chorlton, 1980). The stratified and gabbroic rocks are herein viewed to comprise three main northeast-trending belts, two of which are intruded by the Baggs Hill Granite.

The northern belt is characterized by the widespread occurrence of graphitic, pelitic and semipelitic rocks and a relative paucity of volcanic rocks; the latter are exclusively felsic in composition. The volcanic and sedimentary rocks are interstratified and may comprise an overall right-way-up, southeast-younging succession, marked by moderately low-bulk strain. The belt is host to the Strickland base-metal prospect, in addition to several other VMS-type showings (e.g., Carrot Brook, Big Pond: e.g., Swinden; 1981).

The central belt is a wide shear belt, mainly composed of mylonite, but also including recognizable sedimentary and volcanic rocks. Shear-bounded, variably foliated to mylonitic metagabbro is restricted to this belt, and forms narrow, elongate to podiform bodies varying from several meters up to more than three kilometres in length. Within low-strain areas, the stratified succession differs from adjacent rocks to the north in that it is characterized by a much greater volume of felsic volcanic rocks, by the presence of extensive amounts of immature epiclastic sedimentary rocks, and the relative lower proportion of pelitic and graphitic rocks. The central belt is host to numerous zones of pyritic and silicic alteration. These are found preferentially in high-strain rocks, although alteration also occurs in zones of lower strain.

Between Dolman Cove and Baggs Hill, the boundary of the northern and central belts is a thrust fault. Farther northeastward, a narrow sheet of Baggs Hill Granite truncates this southeast-dipping structure, and regionally demarcates the boundary of these belts.

The Baggs Hill Granite is a weakly foliated, fine grained granite transitional into felsite and micrographophyre. It is intruded as northeast-trending sheets across the entire width of the central belt, and is observed to crosscut mylonite posttectonically. The granite also crosscuts platy sedimentary and volcanic rocks, and massive to sheared metagabbro; all of these country rocks appear as enclaves within these sheet intrusions. The complex interleaving of metagabbro, mylonite and platy stratified rocks

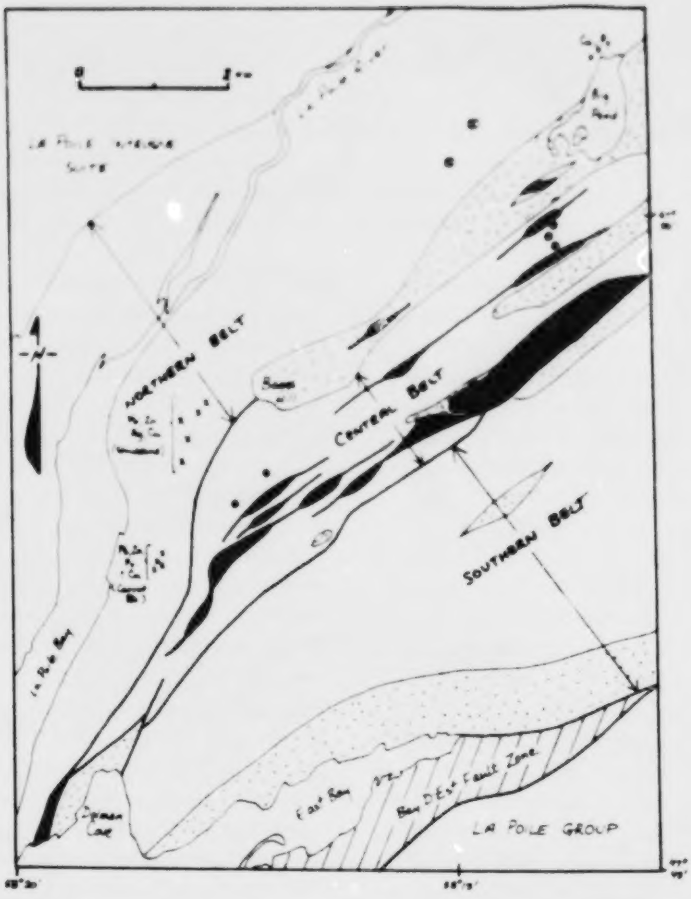
La Poile Intrusive Suite
N
Northern Belt
Central Belt
Southern Belt
La Poile Bay
East Bay
Bay D'Est Fault Zone
La Poile Group

Figure 1. Geological sketch map of the Bay du Nord Group and adjacent units in the region between East Bay and the La Poile River (NTS 11O/16), southern Newfoundland.

Legend to Figure 1

ORDOVICIAN?

- ☐ volcanic rocks of the southern belt (Dolman tuff)
- ⁙ sedimentary rocks of the southern belt

MIDDLE ORDOVICIAN

- ▨ fine grained biotite granite and microgranophyre (Baggs Hill Granite)

EARLY ORDOVICIAN?

- ■ metagabbro

⊗ silicified zone
× mineral showing
—— stratigraphical or intrusive contact
—— fault

occurred prior to the intrusion of Baggs Hill Granite, which is preferentially injected along shear zones in the central belt. In contrast, the Baggs Hill Granite is observed to intrude the northern belt only along the latter's faulted southern margin.

The southern belt is chiefly composed of felsic tuff (Dolman Formation of Chorlton, 1980) characterized by a pervasive southeast-dipping foliation associated with moderately northeast-plunging lineation. This distinctive quartz and feldspar-phyric crystal tuff is locally interbedded with minor amounts of sedimentary rocks. In two localities along its northern faulted contact, an underlying pebble to cobble conglomerate locally separates the felsic tuff unit from the central belt. Coarse grained conglomerates also occur in stratigraphical contact with tuff along its southern boundary. In all of these areas, the conglomerates contain a variety of plutonic and volcanic detritus, including clasts of Baggs Hill Granite.

The individual relationships that each of these three belts has to the Baggs Hill Granite necessitates redefinition of the Bay du Nord Group in its type area. The southern belt may originally have been a cover sequence deposited above the Baggs Hill Granite and its country rocks. The structures that bound the southern belt must be younger than the bounding structure of the northern and central belts. The relative age of rocks and structures within the northern and central belts are unknown.

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A REINTERPRETATION OF THE TECTONIC HISTORY OF PARTS OF THE HERMITAGE PENINSULA, SOUTHWESTERN AVALON ZONE, NEWFOUNDLAND

S.J. O'Brien[1], C.F. O'Driscoll[2] and R.D. Tucker[3]

This project was designed with the goal of establishing the nature, relationship and timing of late Precambrian magmatic and mineralizing events in the southwestern Avalon Zone of the Newfoundland Appalachians. Up until now, work has focussed on determining the precise age and both the internal and external relationships of the Hermitage Complex, the Long Harbour and Connaigre Bay groups, and of adjacent intrusive rocks. This work has significant broader implications for, 1) regional and detailed Avalonian stratigraphic correlations, 2) correlation of magmatic, tectonothermal and mineralizing events across the Avalon Zone, and 3) correlations of these with coeval events recognized in Avalonian (sensu lato) rocks in the southern Hermitage Flexure. Sampling for geochronological analyses was completed in 1990, and the main results of this work are to be published at a later date. Presented below is a brief summary of follow-up mapping carried out in June 1991 on the Hermitage Peninsula, west of Connaigre Bay (Figure 1).

The oldest intrusive rocks in the area occur within the Hermitage Complex[4] and include gabbro and minor diorite ("old" Hermitage Complex) that are intruded by the blue-quartz-phyric Furby's Cove Granite. Both the "old" Hermitage Complex and the Furby's Cove Granite are host to a bimodal (felsite - diabase) dyke swarm. The latter is sited along the west coast of the Hermitage Peninsula, at the edge of the Avalonian rocks, adjacent to the brittle Hermitage Bay Fault. The Furby's Cove Granite is in intrusive contact with rhyolites of the Tickle Point Formation. Near this contact the granite hosts a major fault zone, marked by a 500-m-wide zone of mylonite.

An unconformity separates the above package of rocks from the lowest sedimentary succession of the Connaigre Bay Group (Sam Head Formation). The basal beds of the cover sequence include conglomerate that contains clasts of felsite, quartz, diabase, granite, rhyolite and blue quartz. The unconformity is folded in the Salmonier Cove syncline. Rocks above the unconformity pass gradationally upward into mafic volcanic rocks (Doughball Point Formation). The relationship of the mylonite zone within the Furby's Cove Granite with rocks above the unconformity is, as yet, unknown. Ductile fabrics are not developed in any of the Precambrian cover rocks exposed along the projected strike of the mylonite. The northeast-trending zone extends from the coast of Hermitage Bay, thinning inland; the mylonite zone has been mapped southwards as far as the Hermitage road, near the contact of the Tickle Point Formation with the Doughball Point and Sam Head formations.

A younger diorite - gabbro complex (Grole Diorite), previously unseparated from the pre-Furby's Cove gabbros, crosscuts the older intrusive rocks, the unconformity at the base of the Sam Head Formation, and the overlying sedimentary and volcanic rocks. Lithologically, the Grole Diorite differs from older parts of the Hermitage Complex in that it is relatively homogeneous and unaltered, it contains significantly fewer dykes, and it is associated with a distinctive, coarse grained black gabbro.

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[4] With the exception of the Sam Head Formation (Colman-Sadd *et al.*, 1979), stratigraphic nomenclature follows that of Greene and O'Driscoll (1976) and O'Driscoll (1977).

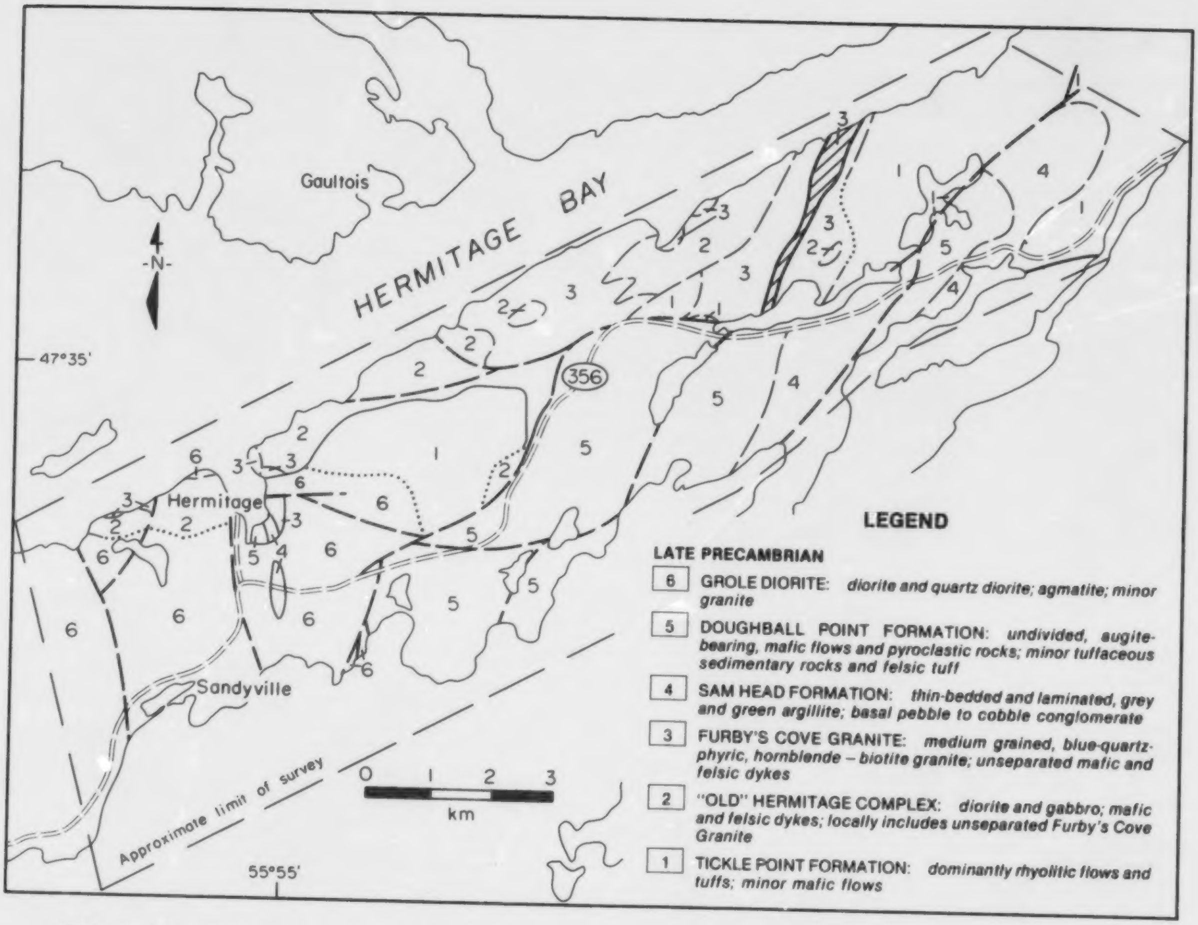
Gaultois
HERMITAGE BAY
-N-
47°35'
Hermitage
Sandyville
356
Approximate limit of survey
0 1 2 3
km
55°55'
1
2
3
4
5
6
LEGEND
LATE PRECAMBRIAN
6 GROLE DIORITE: diorite and quartz diorite; agmatite; minor granite
5 DOUGHBALL POINT FORMATION: undivided, augite-bearing, mafic flows and pyroclastic rocks; minor tuffaceous sedimentary rocks and felsic tuff
4 SAM HEAD FORMATION: thin-bedded and laminated, grey and green argillite; basal pebble to cobble conglomerate
3 FURBY'S COVE GRANITE: medium grained, blue-quartz-phyric, hornblende – biotite granite; unseparated mafic and felsic dykes
2 "OLD" HERMITAGE COMPLEX: diorite and gabbro; mafic and felsic dykes; locally includes unseparated Furby's Cove Granite
1 TICKLE POINT FORMATION: dominantly rhyolitic flows and tuffs; minor mafic flows

Figure 1. Preliminary geological map of part of the Hermitage Peninsula, southern Newfoundland

The Grole Diorite is, in many localities, net veined by granitoid rocks that locally coalesces to form small plutons. The Grole Diorite has a locally developed gneissic banding, interpreted to be the result of intrusion into actively deforming zones.

The Connaigre Bay Group is host to two significant volcanogenic sulphide showings and several base-metal-poor massive pyrite occurrences (Sears, 1990). Almost all the occurrences are found within a limited stratigraphic interval at the top of the Tickle Point Formation. The Winter Hill showing, which is located northeast of the study area, is presently mapped as being hosted by the lower portions of the Sam Head Formation. Drill-hole data indicate, however, that the zone at Winter Hill is underlain chiefly by fragmental felsic and silicified rocks, with lesser amounts of mafic tuffs and flows (Sears, 1990). This could possibly indicate that mineralization at Winter Hill is located at the top of the dominantly silicic Tickle Point Formation, below the unconformity at the base of the Sam Head Formation. It is significant that one of the few known equivalents of the Tickle Point Formation in the Avalon Zone elsewhere in the Canadian Appalachians is host to the former Stirling base-metal mine in Nova Scotia.

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GEOLOGY OF THE AVALON ZONE AND THE EASTERNMOST GANDER ZONE IN THE GLOVERTOWN (NTS 2D/9, EAST HALF) MAP AREA

S.J. O'Brien[1] and R.E. Holdsworth[2]

During a six-week period in the 1991 field season, bedrock mapping of the Avalon Zone and the easternmost Gander Zone within the Glovertown (NTS 2D/9) map area was undertaken. This work is the continuation of the 1:50,000-scale regional mapping program of the northwest Avalon, initiated in 1986.

The Dover Fault traverses the study area (Figure 1), juxtaposing a lower Paleozoic amphibolite-facies granite-gneiss terrane to the west (Gander Zone) with a late Precambrian greenschist-facies, terrestrial to shallow marine, volcano-sedimentary terrane to the east (Avalon Zone).

The Avalonian rocks are disposed in continuous, north- to north-northeast-trending belts. Adjacent to the Dover Fault is a southward-widening tract of inhomogeneously deformed late Precambrian volcanic flows and pyroclastic rocks of rhyolitic to dacitic and, more rarely, basaltic composition. Structurally, the rocks vary from phyllonitic to moderately cleaved, and in some areas carry only a weak fracture cleavage. These rocks have been mapped as part of the Love Cove Group by Jenness (1963) and subsequent workers. The Love Cove tract is succeeded eastward by three belts of clastic rocks collectively assigned by Jenness (1963) to the Musgravetown Group. In the Glovertown area, much of the Musgravetown Group consists of an overall westward-younging, right-way-up succession of yellow-green to grey, cross-bedded sandstones, capped by red sandstone and conglomerate. East of the Terra Nova River, the intensity of deformation within the Musgravetown clastic succession increases significantly. There, the sandstones also contain narrow bands of felsic and mafic volcanic rocks and are host to dykes and small stocks of diorite and diabase.

The contact of the Love Cove rocks with the red sandstone and conglomerate unit at the top of the Musgravetown Group clastic succession is unexposed and is interpreted to be faulted. However, several lines of evidence suggest that the Love Cove belt in this map area is significantly younger than volcanic rocks assigned to the Love Cove Group farther to the southeast in the Eastport (NTS 2C/12) and St. Brendan's (NTS 2C/13) map areas (O'Brien, 1987; O'Brien and Knight, 1988, O'Brien *et al.*, 1991). It is likely that within the study area most, if not all volcanism is, in the broadest sense, coeval with Musgravetown Group sedimentation.

Sillimanite-grade paragneisses and orthogneisses (part of the Hare Bay Gneiss, Blackwood, 1977) are the predominant rock types within the Gander Zone in the map area. Elongate sheets of deformed megacrystic biotite granite intrude the Hare Bay Gneiss and are broadly synkinematic with respect to the regional high-grade metamorphism of the gneisses. Smaller elongate sheets of foliated muscovite-biotite granite are locally associated with the megacrystic bodies; these crosscut both gneiss and megacrystic granite. Throughout the Gander Zone side of the map area, the intrusion of granites and the high-grade metamorphism of gneisses are associated with an early phase ductile sinistral shear. In the central part of the map area, a narrow sheet of medium- to coarse-grained, porphyritic biotite granite (Dover Fault Granite of Blackwood, 1977) has been mapped as a semi-continuous sheet that lies close to and subparallel with the Dover Fault. The granite, intrusive into the Hare Bay gneiss, is everywhere deformed by dextral shearing.

Adjacent to the Dover Fault, a zone of early ductile sinistral transpression, documented

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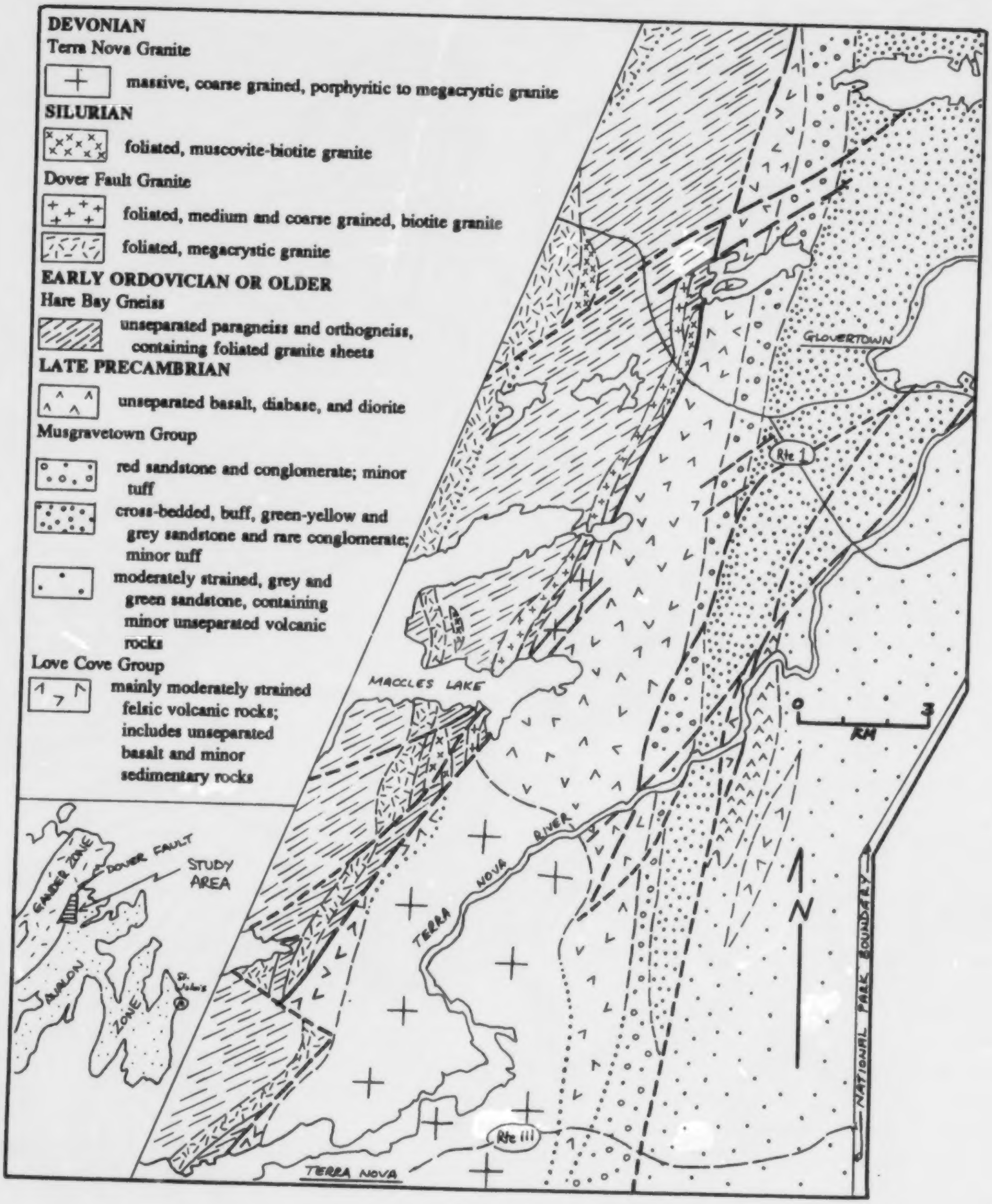
DEVONIAN
Terra Nova Granite
massive, coarse grained, porphyritic to megacrystic granite
SILURIAN
foliated, muscovite-biotite granite
Dover Fault Granite
foliated, medium and coarse grained, biotite granite
foliated, megacrystic granite
EARLY ORDOVICIAN OR OLDER
Hare Bay Gneiss
unseparated paragneiss and orthogneiss, containing foliated granite sheets
LATE PRECAMBRIAN
unseparated basalt, diabase, and diorite
Musgravetown Group
red sandstone and conglomerate; minor tuff
cross-bedded, buff, green-yellow and grey sandstone and rare conglomerate; minor tuff
moderately strained, grey and green sandstone, containing minor unseparated volcanic rocks
Love Cove Group
mainly moderately strained felsic volcanic rocks; includes unseparated basalt and minor sedimentary rocks
GANDER ZONE
DOVER FAULT
STUDY AREA
AVALON ZONE
St. John's
GLOVERTOWN
Rte 1
MACCLES LAKE
0
3
KM
TERRA NOVA RIVER
N
NATIONAL PARK BOUNDARY
Rte 111
TERRA NOVA

Figure 1. Preliminary geological map of the eastern part of the Glovertown map area.

in both Avalonian and Gander rocks, is overprinted by lower grade ductile and then brittle dextral displacements. In the northern half of the Glovertown map area, an almost complete section of later ductile dextral mylonites is preserved within the fault zone. In the southern part of the area, the late ductile mylonites are removed along a brittle dextral fault. The megacrystic Terra Nova Granite post-dates all but the youngest brittle movements along the Dover Fault and in the adjacent Love Cove belt.

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GEOLOGY OF THE NORTHWEST GLOVERTOWN MAP AREA (NTS 2D/9) AND NORTHEAST DEAD WOLF POND MAP AREA (NTS 2D/10)

Patrick O'Neill
Newfoundland Mapping Section

The northeast corner of the Dead Wolf Pond map area (NTS 2D/10) and approximately 60 percent of the northern half of the Glovertown map area (2D/9) were mapped during the 1991 field season (Figure 1). The area lies in the Gander Lake Subzone of the Gander Zone. This work represents a continuation of the bedrock mapping project of this zone, initiated in the Weir's Pond area in 1986. Bedrock exposure is poor west and north of Gambo Pond but good north of Maccles Lake.

West of Gambo Pond, the area is underlain by the Gander Group and the Gander Lake and Middle Ridge granites. Between Maccles Lake and Gambo Pond the area is underlain by a complex mixture of foliated fine-, medium-, coarse-grained and megacrystic granites, sillimanite-bearing Gander Group and Hare Bay Gneiss.

The Gander Group is very poorly exposed and consists of interbedded psammite, semipelite and pelite. The rocks are penetratively deformed and metamorphosed and primary structures are absent. Peripheral to the Gander Lake Granite, rocks of the Gander Group have been converted to hornfelses whereas close to the Middle Ridge Granite the rocks are schistose. Across Gambo Pond, there is a marked change in the rock types, and metasedimentary rocks form a subordinate component to a complex mixture of granite. The former are coarse-grained schists and commonly contain sillimanite. There is no continuous section between these rocks and the Hare Bay Gneiss which outcrops west of the Dover Fault. Therefore, the relationship between the Gander Group and the Hare Bay Gneiss is not definable in this area. West of the north end of Gambo Pond, pelitic and semipelitic rocks of the Gander Group are phyllonitic in the Wing Pond shear zone.

The southern half of the Gander Lake Granite is very poorly exposed (six exposures only located during this field season) and underlies much of the central part of the map area. The granite is homogeneous and massive, megacrystic and biotite-rich. The megacrysts are randomly oriented, are composed of K-feldspar, range up to 6 cm long and form 40 to 50 percent of the rock.

In the western part of the map area, an equigranular, massive, medium- to coarse-grained leucocratic granite is exposed. Feldspar forms 50 to 60 percent of the rock, quartz 30 to 35 percent and mica generally less than 15 percent. Most of the mica is muscovite. Minor amounts of tourmaline are dispersed throughout the rock. This unit is cut by dykes of fine-grained quartzofeldspathic granite. Pegmatitic dykes occur locally. In one locality, abundant gabbro boulders indicate such an outcrop.

South of Gambo Pond, the grade of metamorphism and the nature of the geological units is markedly different from that north of the pond. Pelitic and semipelitic rocks of the Gander Group are typically coarse-grained schists associated with ubiquitous sillimanite. However, approximately 70 percent of the rock comprises a varied suite of granites. These range from fine-grained, weakly to moderately foliated leucocratic granite, medium-grained foliated leucogranite, coarse-grained to megacrystic strongly foliated granite, to weakly foliated megacrystic granite. In several localities, two or more of these granites are associated. The foliated, fine- to medium-grained and megacrystic granites are most common. The latter are earlier, a feature which contrasts with the regional relationships in which the megacrystic granites (unfoliated) are late. Toward the west end of Maccles Lake and northeast of

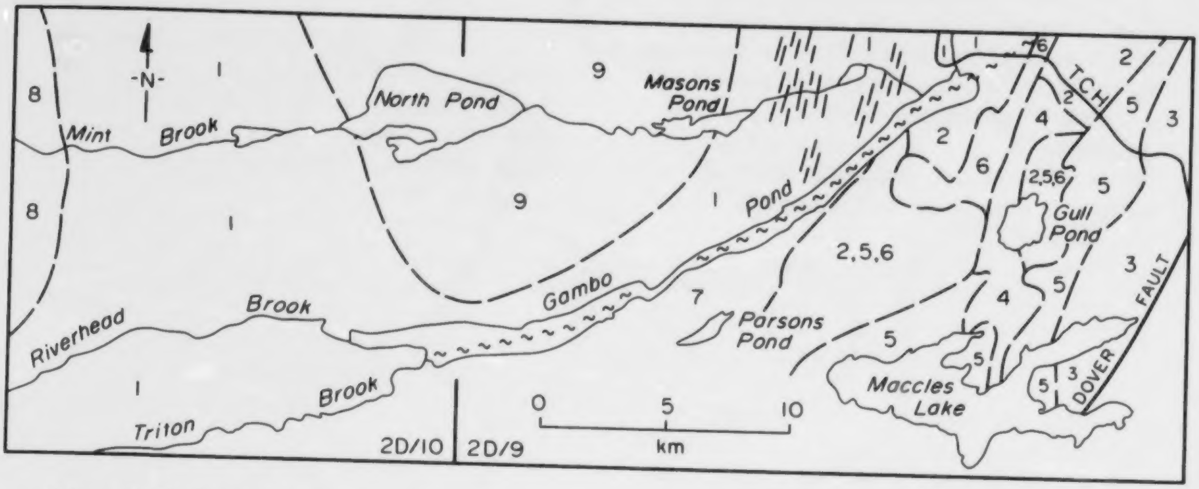
-N-
8
8
1
1
1
1
9
9
Mint
Brook
North Pond
Masons
Pond
Pond
Riverhead
Brook
Gambo
Triton
Brook
7
Parsons
Pond
2
2
2
4
4
6
6
2,5,6
2,5,6
5
5
5
5
5
5
3
3
3
Gull
Pond
TCH
FAULT
DOVER
Maccles
Lake
0
5
10
km
2D/10
2D/9

Figure 1. Geology of the northwest Glovertown map area (2D/9) and the northeast Dead Wolf Pond map area (2D/0).

LEGEND

DEVONIAN

9 Gander Lake Granite

8 Middle Ridge Granite

SILURO-DEVONIAN

7 *Massive, coarse-grained, megacrystic granite (part of old Maccles Lake Granite)*

SILURIAN (?)

6 *Foliated, fine-grained leucogranite: locally contains minor metasedimentary rock (< 30 percent of exposure) and megacrystic granite*

5 *Foliated, megacrystic granite: locally intruded by minor leucogranite (unit 6) and contains minor metasedimentary rock*

4 *Foliated, mixed fine-, medium-, coarse-grained and megacrystic granite: contains minor metasedimentary rock*

EARLY ORDOVICIAN OR OLDER

GANDER GROUP:

3 Hare Bay Gneiss

2 *Predominantly sillimanite-bearing, schistose, coarse-grained metasedimentary rock, commonly intruded by minor foliated, fine-, medium-, coarse-grained and megacrystic granite*

1 *Includes chlorite grade and aureole rocks adjacent to the Gander Lake and Middle Ridge granites*

Parsons Pond, the foliation in the granites, particularly the megacrystic granite, becomes weaker and the megacrystic granite that outcrops on the brook between Parsons Pond and Gambo Pond is massive. This latter may represent part of the Maccles Lake Granite. However, based on the present mapping, the northern contact of this granite requires extensive revision.

The Wing Pond shear zone is best exposed in Mint Brook east of Masons Pond. The strongly foliated to mylonitized rocks mainly comprise a very diverse igneous suite which ranges from granite through to gabbro. Metasedimentary rocks form a minor component.

The nature of the change in lithologic types and grade of metamorphism across Gambo Pond suggests that the lineament defined by the pond and the valley of Triton Brook mark the line of a major fault.

THE IONA ISLANDS INTRUSIONS, PLACENTIA BAY, NEWFOUNDLAND

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PROJECT OVERVIEW

In July 1991, field work for an honours thesis, partly supported by the Department of Mines and Energy, was completed. The purpose of this project is to examine the petrology, geochemistry, and geochronology of the Iona Islands Intrusions in eastern Placentia Bay (Figure 1), and assess their significance to the Avalon Zone. Seventy-five samples were collected for this purpose, of which approximately sixty samples will be analyzed for major and trace elements.

GEOLOGY

The Iona Islands Intrusions are located in eastern Placentia Bay (Figure 1) and are generally considered to be of Paleozoic age; they are estimated to be of Silurian and/or Devonian age by King (1988) and Coleman-Sadd *et al.* (1990). If this is indeed the case, they are then the most easterly example of Paleozoic magmatism in Newfoundland. However, there are no geochronological data on these rocks, and their petrology and geochemistry have not previously been investigated, in any detail. McCartney (1955) studied them as part of a regional mapping project, which covered the southwest Avalon Peninsula. Kerr (1990) conducted some limited sampling for petrological and geochemical work.

The Iona Islands Intrusions are dominated by massive gabbro of variable grain size, which varies in texture from equigranular to plagioclase-porphyritic. The gabbro is intruded and stoped by red, fine to medium grained granite dykes and sills, which are prominent on an outcrop scale in most areas. The granite forms mappable units on Burke Island and Merchant Island, and underlies all of Fox Island (Figure 1). Field relationships suggest that the granitoid rocks are everywhere younger than the gabbro. However, many of the stoped gabbroic blocks are rounded, suggesting that the age difference between the older gabbro and the granite may not be large. Melanocratic granitoid rocks that appear rich in potassium feldspar may represent local hybridization and/or interaction phenomena.

The Iona Islands are associated with an extensive magnetic high that underlies much of eastern Placentia Bay. Therefore, they may be part of a much larger intrusive body, perhaps including the Red Island Granite.

Hornfelsed siltstones of the Musgravetown Group underly the eastern half of Burke Island, and form smaller enclaves on Merchant and Harbour islands. In one location, complex folding patterns interpreted to be original soft-sediment deformation were observed. In areas adjacent to granitoid bodies, these rocks locally display tourmalinization, and granite veins contain vuggy quartz-tourmaline patches. These are indicative of high emplacement levels.

McCartney (1955) mentions a fluorite vein on Harbour Island, and uses this evidence to suggest that the granite intrusion on the Iona Islands may be related to the fluorite-bearing St. Lawrence Granite. However, this fluorite vein has not been relocated by the present investigator.

OUTLINE OF PROPOSED RESEARCH

Proposed research for the B.Sc. thesis will focus on the petrology, geochemistry and geochronology of the Iona Islands Intrusions.

Comparative geochemical studies will be used to investigate the possibility of direct and/or genetic links between the Iona Island Intrusions and other probable Paleozoic plutons of the Placentia Bay area. The relationships of mafic and felsic magmas within the Iona Islands Suite will also be investigated to test whether they

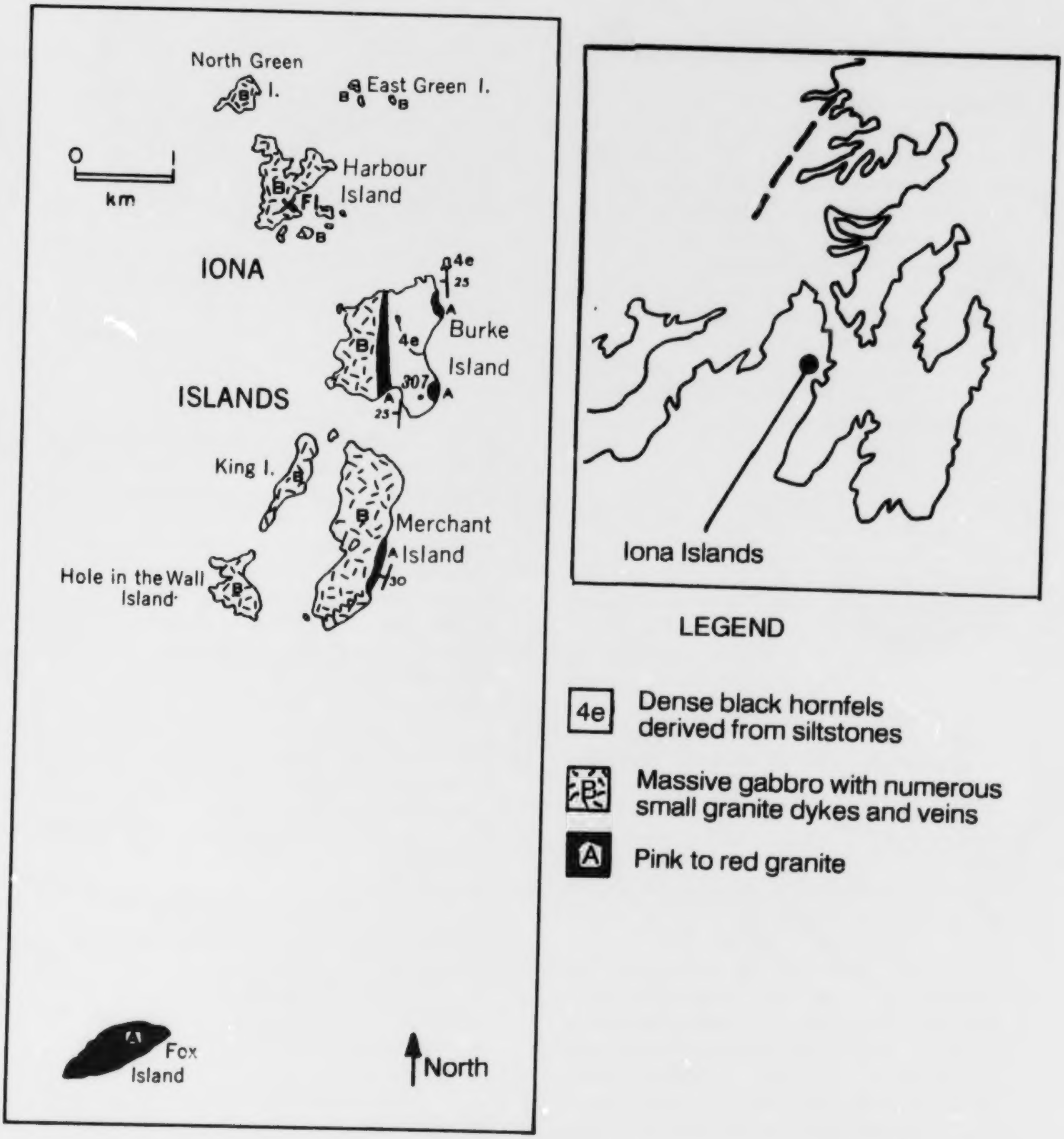
North Green I.
East Green I.
B
0
1
km
Harbour Island
F
IONA
ISLANDS
4e
25
A
Burke Island
307
King I.
Merchant Island
30
Hole in the Wall Island
Fox Island
North
Iona Islands
LEGEND
4e Dense black hornfels derived from siltstones
B Massive gabbro with numerous small granite dykes and veins
A Pink to red granite

Figure 1. Location and general geology of the Iona Islands Intrusions, Placentia Bay. The geology map is taken from McCartney (1955); some minor revisions may be made when data are collated and interpreted.

were derived from a common parent magma or from radically different sources.

Finally, it is hoped that Rb-Sr (and possibly Sm-Nd) geochronology can be used to obtain emplacement ages for the mafic and felsic components of the suite, and develop a petrogenetic model in conjunction with the geochemical evidence. The nature of any basement rocks beneath the Avalon Zone is largely conjuctural, due to the fact they are nowhere exposed. The Nd and Sr isotopic signatures of Paleozoic (?) intrusions such as the Iona Island Suite may provide "windows" through which the characteristics of Avalonian basement can be ascertained.

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GEOCHEMISTRY / GEOPHYSICS

URBAN GEOCHEMICAL - MAPPING ANTHROPOGENIC CHANGES IN THE DRAINAGE SYSTEMS OF ST. JOHN'S AND ENVIRONS

Terry K. Christopher[1], Peter H. Davenport[2], Larry W. Nolan[2] and Pauline Honarvar[2]

INTRODUCTION

Lake sediments and waters were collected throughout the city of St. John's and its suburbs to map the nature and extent of geochemical variations due to urban development (Christopher, 1991). Lakes are widely distributed throughout the area and lake sediment and water provide an efficient way of sampling the drainage network. Geochemical background data are available for the whole of Newfoundland based on a comprehensive collection of lake-sediment samples from over 16,000 sites (Davenport and Butler, 1983) and a reconnaissance lake-water survey of 109 lakes (Scruton, 1983), permitting a comparison of abundance levels within the urban region as a whole with other geologically similar but less disturbed areas.

The St. John's area is underlain by rocks of Late Precambrian (Proterozoic III) age (King, 1990). Mafic (HHm) and felsic (HHf) volcanic rocks occur along the western boundary (Figure 1), and these are overlain by, from west to east, sandstone and tuffaceous siltstone (HCG - Conception Group), black shale and sandstone (HSJ - St. John's Group) and red sandstone and conglomerate (HSH - Signal Hill Group). Over 80 percent of the area is covered by a till veneer of local provenance which is typically less than 3 m in thickness (King, 1990).

SAMPLING AND ANALYSIS

Sediment and water samples from 60 sites were collected from most lakes within a 320 km^2 area that included the urban core and suburbs. Duplicate sediment and water samples were taken from 52 sites to allow sampling variance to be well characterized. Water samples were collected from a depth of about 20 cm in clean 250 mL polyethylene bottles. All waters collected were clear with very little suspended solids, and varied from colourless to brown (organic) in colour. After pH determination, the waters were passed through a 0.45 micron filter and acidified with 1 mL of HNO_3 for storage prior to chemical analysis. The waters were analyzed directly by ICP-OES for Al, Ba, Be, Ca, Cu, K, Mg, Mo, Na, S (as SO_4), Si (as SiO_2), Y, and Zn.

Sample cores, 6 cm in diameter of the upper 20 to 30 cm of organic lake sediment were collected from the central, deeper basins of lakes using a tubular steel sampler, inspected and placed in Kraft paper bags. The sediments were of thixotropic, dominantly organic material composed of diatoms and other authigenic micro-organisms, together with fine-grained allogenic clastic and organic material. The sediments were oven-dried at 40°C, mechanically crushed and sieved to <0.18 mm to remove any coarse debris and homogenize the material. The dried (but unashed) sediments were analyzed for 47 elements (total content): As, Au, Br, Co, Cs, Eu, Fe, Hf, La, Lu, Mo, Na, Sb, Se, Sm, Ta, Tb, Th, U, W and Yb by INAA, and Al, Ba, Be, Bi, Ca, Ce, Cr, Cu, Dy, Ga, K, Li, Mg, Mn, Nb, Ni, P, Pb, Rb, Sc, Sr, Ti, V, Y, Zn and Zr by a combination of ICP-OES and AAS, following an $HF\text{-}HClO_4\text{-}HCl$ digestion. Organic carbon content was estimated from loss-on-ignition at 500°C and, in addition, aqua-regia-soluble levels of Ag, Cd, Co, Cu, Fe, Mn, Ni, Pb and Zn were determined by AAS. Comparison of the total and aqua-regia extractable values showed the latter to be very nearly total for this whole suite of elements.

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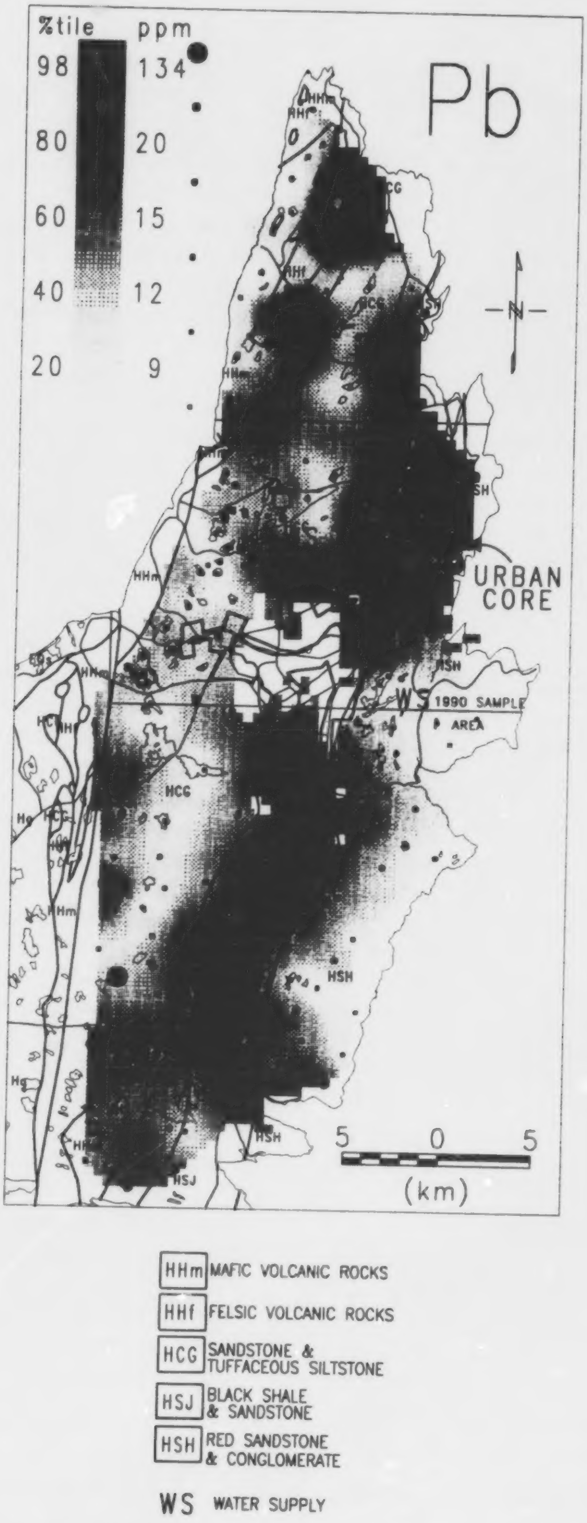
%tile
ppm
98
134
80
20
60
15
40
12
20
9
Pb
N
URBAN CORE
WS
1990 SAMPLE AREA
HHm
HHf
HCG
HSH
HSJ
Hg
5
0
5
(km)
HHm MAFIC VOLCANIC ROCKS
HHf FELSIC VOLCANIC ROCKS
HCG SANDSTONE & TUFFACEOUS SILTSTONE
HSJ BLACK SHALE & SANDSTONE
HSH RED SANDSTONE & CONGLOMERATE
WS WATER SUPPLY

Figure 1. Pb in lake sediment from 246 sites on the northeast Avalon Peninsula.

RESULTS

Both natural and anthropogenic variations in Pb are displayed in the lake-sediment data from the northeastern part of the Avalon Peninsula (Figure 1). Geological control of background Pb values is illustrated by generally elevated Pb in lake sediment over the shale-rich St. John's Group (HSJ), but the highest Pb values are concentrated where the urban area overlies the St. John's Group.

In comparison with the reconnaissance data for Na in lake water, the whole region around St. John's is above the upper limit of the regional background for Newfoundland, even for a coastal area where marine aerosols are a major source of Na (Scruton, 1983). Sulphate values in lake waters in St. John's are also well above the provincial background, with the highest values forming a tight cluster over the older part of the city.

DISCUSSION

Lakes in the oldest and most urbanized part of St. John's show the most geochemical change. Geochemical background data from adjacent, less disturbed areas and from the region as a whole are necessary to appreciate the magnitude of the changes such as those of Pb in sediment and Na and SO_4 in waters. Levels of other metals in sediment (Ag, Au, Ba, Cd, Cr, Cs, Cu, F, Hf, Lu, Ni, Rb, Sb, Sc, Ta, Th, U, V, W, Yb and Zn) are elevated in the inner city core, but not in all cases above geochemical background. For lake water, apart from pH and major ions, there are insufficient background data to compare with the values observed in this study.

Although the distribution patterns in lake water and sediment are quite similar for some elements, in general, the two media provide rather different but complementary information. Lake sediment gives a geochemical signal integrated over several years of deposition that reflects the sum of human activities (farming, deforestation, construction, waste disposal, industry, etc.) as well as natural physical, chemical and biological processes operating in the catchment basin. The effects of some of these processes on anthropogenic patterns can be reduced by multiple regression against process indicators, and techniques such as Principal Component Analysis can be used to indentify the main spatial associations of the measured geochemical parameters.

Lake water provides a transient reflection of drainage geochemistry at the time of sampling, and the single samples discussed here present a "snapshot" of the situation in October, 1990. As water-quality guidelines have been established for several elements and compounds, the results can be used directly to assess the seriousness of any man-made changes. Duplicate samples demonstrated that lake waters are very homogeneous, but the very low (ppt) level of many trace elements posed analytical problems, and only Al, Ba, Ca, Fe, K, Mg, Mn, Na, SO4, Sr, Zn and pH have been adequately determined in this study. As concentration levels are typically much higher in lake sediment, a much wider element suite can be easily obtained (45 elements in this study). Thus sediment provides a cost-effective method of gaining an overview of the nature and location of environmental changes allowing follow-up to be focussed on the main problem areas.

CONCLUSION

A geochemical survey of lakes in the St. John's area has shown that urbanization has modified the natural geochemical environment, and has indicated the nature and location of the main changes. Many aspects remain to be studied in detail: e.g., the history of SO_4 and heavy metal pollution and their sources, and a more complete study of water chemistry, examining more elements, their interrelationship and seasonal variability. The results show that many changes have been fairly modest and localized. Even in the area of strongest pollution in the inner city the lakes are eutrophic with near neutral pH, and the drainage systems maintain a viable population of trout and arctic char, although periodic fish kills do occur. Futhermore, the region's water supply is from three lakes

(WS in Figure 1) none of which shows evidence of contamination. The results provide an overview of the geochemical environment in 1990 on which more detailed and focussed studies can be based, and will be useful in planning any future environmental monitoring program.

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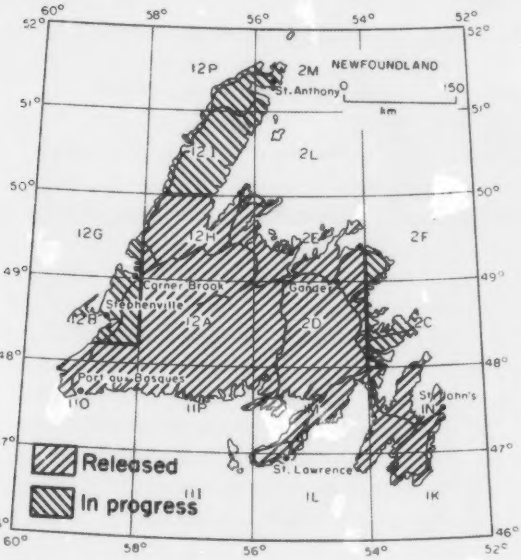
GEOCHEMICAL MAPPING OF NEWFOUNDLAND AND LABRADOR: PROGRESS FOR 1991

P.H. Davenport[1], P.W.B. Friske[2], E.H.W. Hornbrook[2] and L.W. Nolan[1]

An archived, regional drainage sediment sample set covers the entire province (organic lake sediment for most of the province, with stream sediment from the Torngat Mountains of northernmost Labrador), with the exception of the St. John's urban area, the National Parks and some Provincial Parks. The gap in coverage in the St. John's area was closed by a small survey in October 1990 (Christopher *et al., this volume*). Lake sediment from Newfoundland is being reanalysed systematically in two stages to expand the element suite from the initial, limited, 11 elements (Ag, Co, Cu, F, Fe, Mn, Mo, Ni, Pb, U, and Zn) plus loss-on-ignition, to add, firstly, Au, As, Ba, Br, Ce, Cr, Cs, Eu, Hf, La, Na, Rb, Sb, Sc, Se, Sm, Ta, Tb, Th, W and Yb by multi-element neutron activation analysis (NAA), and, secondly, Al, Be, Ca, Cd, Ga, K, Li, Mg, Nb, P, Sr, Ti, V, Y and Zr by ICP optical emission spectrometer (ICP).

The reanalysis program in Newfoundland is being carried out by the Geological Survey Branch, and progress to November 1, 1991, is shown in Figures 1 and 2. For the NAA suite, results for NTS sheets 1K, 1L, 1M, 1N, 2D, 2E, 11O, 11P, 12A and 12H have been released (Table 1 and Figure 1), as well as for parts of 12 B (1-3), and 12 I (1), and analysis of samples from the remaining areas is currently under way. Analysis of samples by ICP is complete for NTS sheets 2E, 11O and 12H, with results to be


60°
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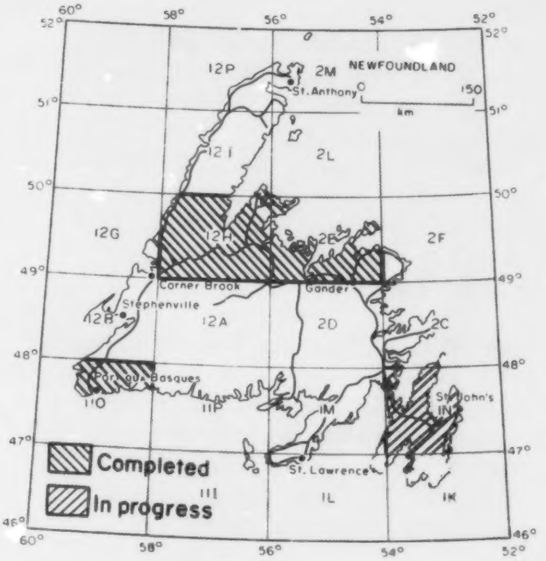
12P
2M
NEWFOUNDLAND
St. Anthony
0
150
km
12I
2L
12G
12H
2E
2F
Corner Brook
Gander
Stephenville
12B
12A
2D
2C
Port aux Basques
11O
11P
St. John's
1N
St. Lawrence
1M
1L
1K
▨ Released
▧ In progress

Figure 1. Index map showing progress with analysis of regional lake sediment samples in Newfoundland by NAA for Au, As, Ba, Br, Ce, Cr, Cs, Eu, Hf, La, Na, Rb, Sb, Sc, Se, Sm, Ta, Tb, Th, W and Yb.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NEWFOUNDLAND
St. Anthony
0
150
km
12I
2L
12G
12H
2E
2F
Corner Brook
Gander
Stephenville
12B
12A
2D
2C
Port aux Basques
11O
11P
1M
St. John's
1N
St. Lawrence
1L
1K
▧ Completed
▨ In progress

Figure 2. Index map showing progress with analysis of regional lake sediment samples in Newfoundland by ICP for Al, Be, Ca, Cd, Ga, K, Li, Mg, Nb, P, Sr, Ti, V, Y and Zr.

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Table 1. List of open files for gold and associated elements by neutron activation analysis (NAA) in regional lake sediment for Newfoundland and Labrador

NTS Area(s)	Open File	Release Date	Reference
NEWFOUNDLAND			
11 O (all) 12 I/1	Nfld.1582	1987-09-24	Davenport and Nolan, 1987
2 E (all)	2E/563	1988-08-02	Davenport and Nolan, 1988
2 D (all)	2D/175	1988-11-01	Davenport *et al.*, 1988
11 P (all)	11P/137	1989-03-29	Davenport *et al.*, 1989a
12 H (all)	12H/1012	1989-06-06	Davenport *et al.*, 1989b
12 B/1-3 12 B/1-3	Nfld. 1801	1989-07-11	Davenport *et al.*, 1989c
1 M (all)	1M/312	1990-05-30	Davenport *et al.*, 1990a
12 A (all)	12A/561	1990-08-28	Davenport *et al.*, 1990b
1 N (all)	1N/499	1990-09-18	Davenport *et al.*, 1989c
1 K (all)	1K/25	1991-07-31	Davenport and Nolan, 1991a
1 L (all)	1L/136	1991-07-31	Davenport and Nolan, 1991b
LABRADOR			
Parts of 13 I, 13 J, 13 K, 13 N and 13 O	GSC OF 1636 (revised 1989)	1988-08	Hornbrook and Friske, 1988
Parts of 23 I, 23 J and 23 O	GSC OF 2037	1989-10	Hornbrook and Friske, 1989

released on open file by the end of 1991, and is in progress for 1N (Figure 2).

In Labrador (Figure 3) the reanalysis program is being done by the Geological Survey of Canada as part of the National Geochemical Reconnaissance Program, and results for the NAA suite have been released for lake sediment from NTS sheet 13O and parts of sheets 13J, 13K and 13N in eastern Labrador, and the Labrador portions of 23I, 23J and 23O in western Labrador data (Hornbrook and Friske 1988, 1989). Work is in progress to complete the reanalysis of the entire lake- and stream-sediment sample set.

The results for gold and associated elements have stimulated mineral exploration in

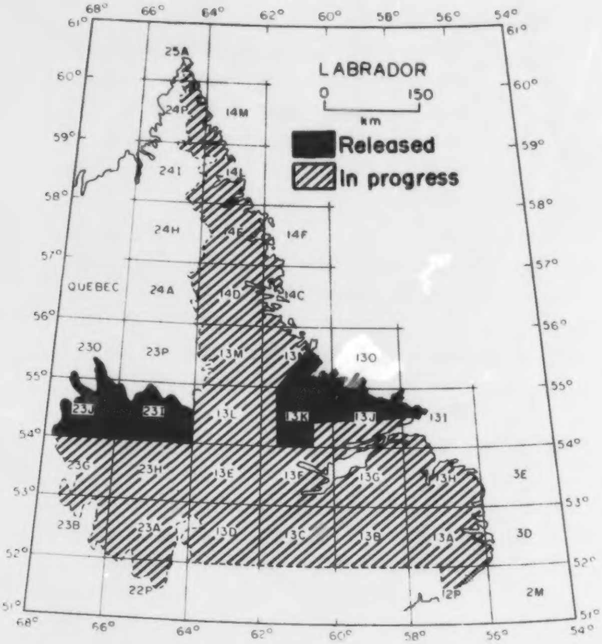

Figure 3. Index map showing progress with the analysis of archived regional drainage sediment samples in Labrador by NAA for Au, As, Ba, Br, Ce, Cr, Cs, Eu, Hf, La, Na, Rb, Sb, Sc, Se, Sm, Ta, Tb, Th, W and Yb.

the province by identifying new target areas of potential gold mineralization. In addition, the NAA data contain considerable information on the natural variations in background level of several elements that are either essential or toxic to plants and animals, and the list of environmentally important elements is further increased by the ICP suite. The initial surveys and the reanalysis projects have been supported since 1973 by the Governments of Canada and Newfoundland and Labrador through a series of Mineral Development Agreements, and the geochemical mapping program is continuing in both Newfoundland and Labrador under the new Canada - Newfoundland Cooperation Agreement on Mineral Development 1990-1994.

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BIOGEOCHEMICAL EXPLORATION IN NEWFOUNDLAND: PRELIMINARY STUDIES[1]

Colin E. Dunn
Geological Survey of Canada

During a three day period early in June, 1991, orientation studies were conducted in two areas (Figure 1) on the Baie Verte Peninsula, and over the Holyrood granite and the Avalon Peninsula. Tree tissues (mostly black spruce twigs and bark) were collected at roadside sites from near Baie Verte southward to the virginite occurrence at Flatwater Pond. Samples were taken from sites close to those of stream and lake waters collected by Finch *et al.* (*this volume*) in order to assess the levels of metals in trees from this area, and to compare regional patterns of metal distribution with those determined in the waters. Preliminary data indicate enrichment of Ni and Cr in trees at several sites, and some unusually high concentrations of gold (up to 600 ppb Au in bark ash, compared to approximately 10 ppb Au commonly found in spruce bark remote from gold mineralization).

West of St. John's, detailed studies of groundwater chemistry and movements have been made by J. Gale, R. MacLeod and S. Schillereff (Memorial University) in the vicinity of the Holyrood granite. A few samples of common trees and shrubs were obtained from areas of known groundwater recharge and discharge in order to provide both a preliminary assessment of metal concentrations in the vegetation and to study the effects of water chemistry and movement on the chemistry of plants. This information is of value in establishing the spatial relationship of biogeochemical data to zones of metal enrichment in the substrata, and hence provides an improved understanding of biogeochemical methods with respect to mineral exploration. Analytical data are pending.

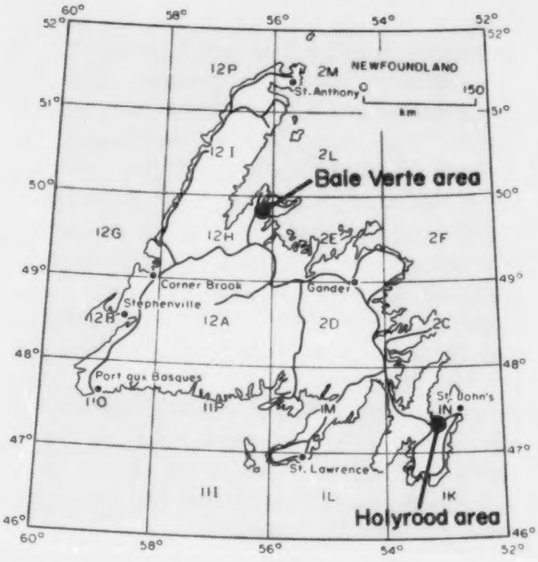

Figure 1. Location of orientation study areas.

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[1] Contribution to the Canada - Newfoundland Cooperation Agreement on Mineral Development 1990-1994

THE DEVELOPMENT OF ANALYTICAL METHODS FOR LAKE AND STREAM WATERS FOR GEOCHEMICAL EXPLORATION

C. Finch[1], G.E.M. Hall[2] and J.W. McConnell[1]

A scheme for the rapid analysis of natural fresh water samples for a wide range of elements to levels below their average abundances is being developed based on ICP-ES (inductively coupled plasma emission spectrometry) and ICP-MS (inductively coupled plasma mass spectrometry) techniques. The methods developed under this project, which is being conducted jointly by the Geological Survey Branch and the Geological Survey of Canada, will be used to evaluate the effectiveness of water as a sample medium for geochemical exploration. The project brings together results and techniques from several earlier projects both in Newfoundland (Christopher *et al., this volume*) and elsewhere in Canada, and involves laboratories at the Geological Survey of Canada (AAS and ICP-MS), Memorial University of Newfoundland (ICP-MS) and the Geological Survey Branch (ICP-ES).

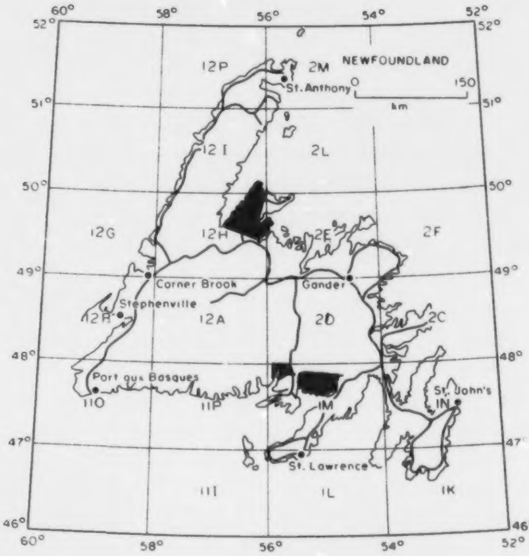

Figure 1. Index map of survey areas.

In June 1991, a water-sampling program was conducted in which 40 stream-water samples were obtained from the Baie Verte and Springdale peninsulas and the St. Alban's area, and one hundred and thirty six lake-water samples were collected in the Bay d'Espoir - Fortune Bay area (Figures 1, 2 and 3). Seven pairs of site duplicates were collected in the stream survey and 12 pairs in the lake survey. Most of the stream sites had been sampled for overbank and active sediment in 1990 and at the same time vegetation samples were collected (Dunn, *this volume*), thus the water data may be compared with the sediment data for effectiveness in reflecting mineralization and catchment basin geology. The stream-sediment data have strong geochemical relief in base metals, arsenic, antimony and gold. The areas of lake-water sampling were selected in the expectation that the data will show strong relief in base metals, arsenic, antimony, and rare earth elements. The selection was based largely on data from reconnaissance lake sediment surveys.

Table 1 summarizes the suites of elements determined thus far in the three laboratories and the methods used. In addition, pH and conductivity were determined in the field. The overlap in the suites will facilitate a comparison of analytical methods. Table 2 summarizes the work to be accomplished this winter. The results from the water samples will be compared with those from other sample media (lake sediment, active stream sediment, overbank sediment and vegetation) to assess the relative effectiveness of water as a sample medium for geochemical exploration. The results will also give a measure of the natural variability in surface waters of a wide range of elements from two geologically distinct areas of Newfoundland, beginning a database of baseline geochemical

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[1] Geochemistry and Geophysics Section; [2] Geological Survey of Canada

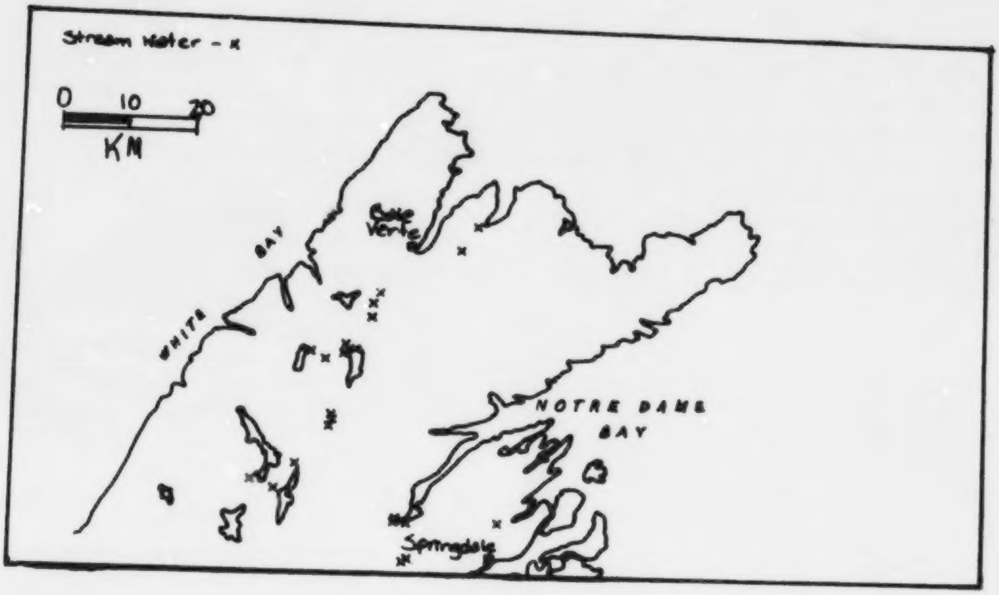
Stream Water - x
0 10 20
KM
Baie Verte
WHITE BAY
NOTRE DAME BAY
Springdale

Figure 2. Location of stream-water sites; Baie Verte and Springdale peninsulas.

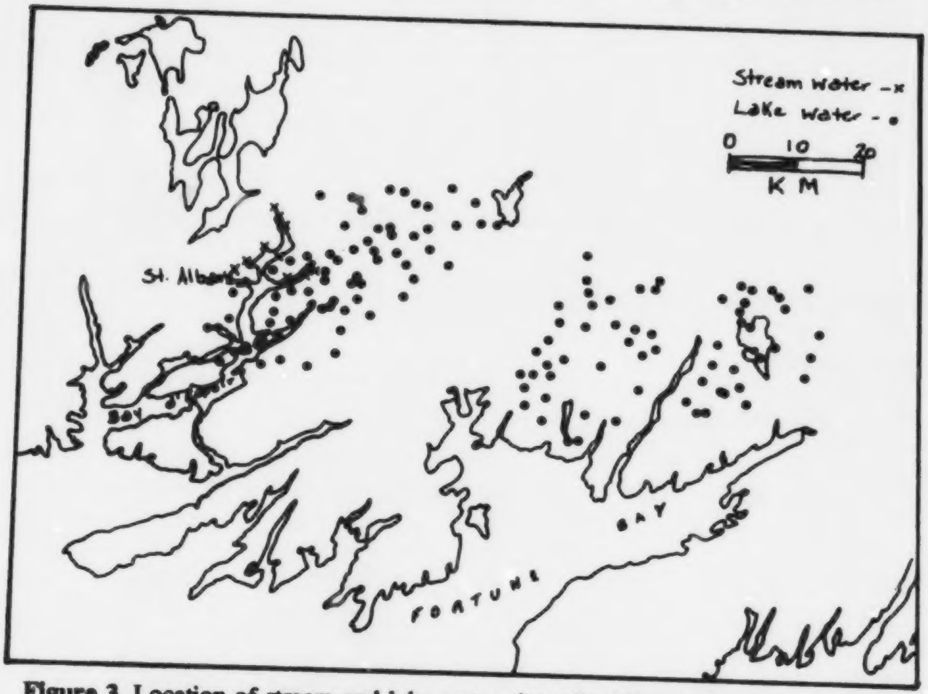
Stream Water - x
Lake Water - •
0 10 20
KM
St. Albans
FORTUNE BAY

Figure 3. Location of stream and lake-water sites; St. Albans - Fortune Bay area.

Table 1. Analyses performed to date by participating laboratory. (NDME - Newfoundland Department of Mines and Energy; MS - Mienhard; USN - ultrasonic nebulizer; MUN/CERR - Memorial University / Centre for Earth Resources Research; GSC - Geological Survey of Canada; HG - hydride generation; ISE-ion selective electrode; QT-AAS - quartz tube atomic absorption spectrophotometry; F - flame)

NDME Laboratory			MUN/CERR		GSC Laboratory			
ICP-ES-MH	ICP-ES-USN		ICP-MS		HG-ICP-MS	ISE	QT-AAS	F-AAS
Si	Li	Cr	Li	Br	Se	F	As	Na
Ca	Be	Mn	Be	Se	Te			K
Mg	B	Co	B	Rb	Bi			Ca
Na	Al	Ni	Mg	Sr	Sb			Mg
K	P	Cu	Al	Mo				Mn
S	Fe	Zn	Si	Ag				Fe
	Sr	Y	P	Cd				Zn
	Ba	Mo	S	Sn				
	Ti		Cl	Sb				
			Ca	I				
			Ti	Cs				
			V	Ba				
			Cr	La				
			Mn	Ce				
			Fe	Hg				
			Co	Tl				
			Ni	Pb				
			Cu	Bi				
			Zn	U				
			As					

Table 2. Analyses to be performed during winter of 1991-92

NDME Laboratory		GSC Laboratory		
ICP-ES-MN	ICP-hydride generation	IC-ICP-MS	IC	UV/Conductivity
C	As, Se, Sn, Sb, Te Hg, Pb, Bi	REEs (i.e., La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu)	SO_4^{2-} PO_4^{2-} Cl^-	Organic C
		Y	Br^-	
		Mn	NO_3^-	
		Co		
		Ni		
		Cu		
		Zn		
		Cd		
		In		
		Pb		

IC - ion chromatography; UV - ultraviolet data for the province in this biochemically important medium.

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GEOPHYSICAL AND GEOCHEMICAL DATABASE

P. Honarvar and G. Kilfoil
Geochemistry and Geophysics Section

The Canada - Newfoundland Cooperation Agreement on Mineral Development (1990-1994) is supporting a pilot study designed to capture extant geophysical and geochemical data from external reports (including non-confidential assessment reports) on file at the Newfoundland and Labrador Department of Mines and Energy. The widespread use of computers for data storage, analysis, and output has prompted the need to digitally capture this data, add it to the Provincial digital geoscience database and make the digital data available to the public.

The initial focus of this project has been a review of the files and an assessment of the quality, quantity and diversity of the data contained in them. The voluminous amount of information available in the reports has dictated the need for a pilot study on a subset of the data. Labrador is an underexplored area, as suggested by the industry/government Technical Liason Committee, which needs to capture the interest of the exploration industry. Airborne geophysical surveys for Labrador were chosen for the pilot study because a large number of surveys have been completed. The reconnaissance nature of these surveys provides a good overview of areas of past and present exploration interest in Labrador. These surveys also complement the Geological Survey of Canada's airborne magnetic surveys presently being processed by G. Kilfoil (*this volume*).

The optimal method of incorporating geophysical data into the compilation database is by obtaining the original digital data files from the exploration companies, which sponsored the surveys. As such, the exploration companies were contacted and requested to provide their digital data to the project. Aside from the savings in time and effort, there are certain advantages in obtaining original rather than interpreted survey information; namely the elimination of biases in modeling the data and errors in transcribing from one medium to another.

As of October 1991, an index of airborne geophysical surveys for Labrador, complete to 1990, has been compiled and digitized. The bibliographic information for each survey was downloaded from the GEOSCAN database and reformatted for use in such programs as Rbase and dBase III+. The authors are currently assessing computer programs, which will provide a link between the graphical map index and the bibliographic information.

Data which is not provided in digital form must be captured manually. Various methods of data capture are being assessed to determine those which are the most accurate and cost-effective. An aeromagnetic contour map for the Florence Lake area (Assessment Report Lab/704) was digitally scanned to capture the flight lines and the contour lines. Input by digital scanning is dependent on the quality of the map being scanned and the result generally requires extensive post-processing and editing. The contour map was also manually digitized by inputting the flight-line/contour-line intersections. This method is time consuming but more robust as it is not as dependent on map quality or size.

Certain benefits are realized by digitally capturing a large database, such as the standardization of the various types of data and the establishment of a data-quality classification system. These benefits should enable users to more easily integrate geophysical, geochemical and geological databases as well as other databases already developed or currently being developed (see J. Butler, *this volume*). Modern exploration techniques are incorporating Geographic Information Systems (GIS) and other image analysis and display systems to be more competitive and cost effective. The comprehensive digital geoscience database being compiled by the Department of Mines and Energy provides an excellent framework for the GIS technology.

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PROCESSING OF REGIONAL GEOPHYSICAL DATA IN THE PROVINCE: AN UPDATE

G. Kilfoil
Geochemistry and Geophysics Section

The Geological Survey of Canada (GSC) gridded aeromagnetic dataset for insular Newfoundland was released as Open File Nfld 2063, in October, 1990. This dataset was accompanied by an IBM compatible program (DISPLAY) for viewing the gridded files in colour on a VGA monitor (Open File Nfld 2064). The industry response for the aeromagnetic data has been very good and has prompted a decision to process and release the aeromagnetic data for Labrador and the airborne gamma-ray data available for Newfoundland in a similar fashion.

In processing the aeromagnetic data for Labrador, precedence was given to areas where field geologists from the Department were mapping during the 1991 field season. Colour shaded-relief maps were produced for all field geologists working in Labrador prior to their departure to the field. These maps were generated at scales of 1:250,000 and 1:100,000 from the corrected regional dataset and were supplemented by digital outlines of lakes, streams, coastline and roads from the 1:250,000 digital topographic data. Field geologists have reported the colour maps to be particularly useful for correlating geology into unmapped regions or areas covered by bodies of water or extensive surficial deposits. In the process of generating these maps, nearly two-thirds of the aeromagnetic data for Labrador was filtered and processed to a gridded dataset. The remainder of the aeromagnetic data is being processed and scheduled for release as a digital open file by the end of November, 1991. Correction of these data should be more routine than that for Newfoundland, as surveys in Labrador are of more recent vintage. However, the data will require a levelling adjustment between adjacent survey areas. The Labrador dataset is being gridded to 200 m on a UTM coordinate system in UTM zone 20.

The processing of the GSC gamma-ray dataset for Newfoundland was initiated with a pilot project undertaken on data collected in 1988 in the Baie Verte area (GSC Open File 1993). A combination of adaptive trim mean filters applied along flight lines to eliminate outliers in the data followed by directional wavenumber domain filtering to remove inter-line levelling problems produced the best results in terms of correlating features in the data with geological features mapped on the surface. Since the gamma-ray radiometric response is severely attenuated by bodies of water, the results are best interpreted by first blanking out areas in the gridded dataset enclosed by lakes and coastline from the 1:250,000 digital topographic dataset. When viewed as a colour, shaded-relief image and illuminated with various angles, the Baie Verte dataset shows many linear features that were not previously identified in the geological mapping or in other data types. The radiometric data is very complementary to the aeromagnetic dataset in that areas underlain by granitic rocks are best discriminated by their radiometric response whereas these areas are often comparatively featureless in the magnetic data.

The processing methods employed in this survey are being applied to the 5 other survey areas currently available in the province. This first pass at processing the digital radiometric dataset for Newfoundland, yielding a gridded dataset comparable to the aeromagnetic data already released, should be completed and ready for release as an Open File by early November 1991.

STREAM SEDIMENT AND WATER FOLLOW-UP SURVEYS IN THE TORNGAT REGION OF LABRADOR

John W. McConnell
Geochemistry and Geophysics Section

The Torngat region of Labrador, including parts of NTS 14E, L and M and 24I and 24P, has received little mineral exploration attention to date with the exception of the Ramah Group of supracrustal rocks. A stream-sediment and stream-water geochemical exploration program was undertaken in the area this summer (Figure 1). Areas were selected primarily on the basis of elevated levels of base metals and/or gold in data from a previous reconnaissance scale stream-sediment survey. The survey included parts of the Nain and Churchill provinces. Bedrock in sampled drainage basins of the Churchill Province is typically granulite facies paragneiss and orthogneiss, and in the Nain Province is generally amphibolite to granulite-facies quartzofeldspathic gneiss with local inclusions of variably deformed supracrustal sedimentary and volcanic rocks.

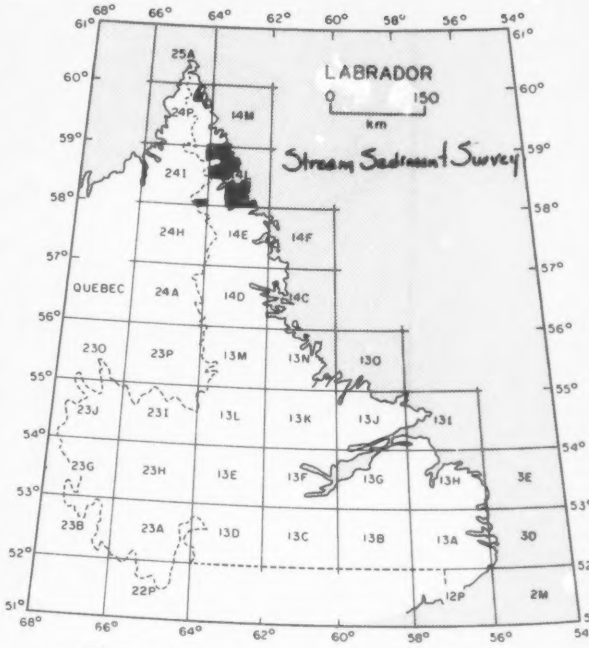
LABRADOR
0 150
km
Stream Sediment Survey
QUEBEC
25A
24P
14M
24I
14L
24H
14E
14F
24A
14D
14C
23O
23P
13M
13N
13O
23J
23I
13L
13K
13J
13I
23G
23H
13E
13F
13G
13H
3E
23B
23A
13D
13C
13B
13A
3D
22P
12P
2M
68°
66°
64°
62°
60°
58°
56°
54°
61°
60°
59°
58°
57°
56°
55°
54°
53°
52°
51°

Figure 1. Index map of stream survey.

Active stream sediment was collected from 241 sites (Figure 2) and will be analyzed for a large suite of elements by neutron activation, atomic absorption spectroscopy and inductively coupled plasma emission spectroscopy. Heavy-mineral concentrates (HMC) were obtained from 117 sites by field panning with conical pans and will be analyzed for the same elements as the active sediment. The HMC samples were collected from areas considered to have potential for gold or platinum-group-element mineralization. Stream-water samples were collected from 71 sites with potential for base metal mineralization and will be analyzed for a smaller range of elements. In addition, 27 rock samples were obtained from local representative outcrops and from newly discovered mineralization.

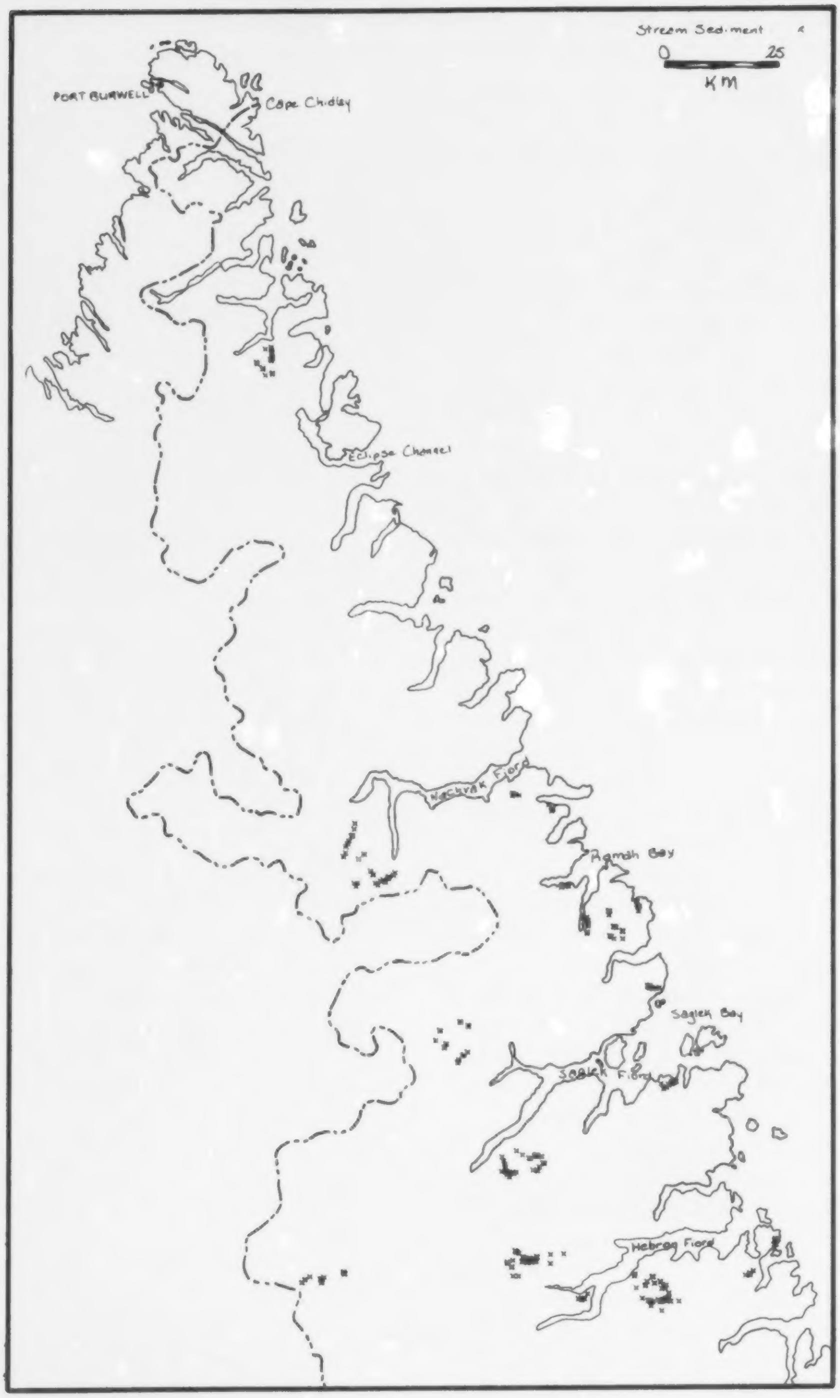
Stream Sediment
0
25
KM
PORT BURWELL
Cape Chidley
Eclipse Channel
Nachvak Fiord
Ramah Bay
Saglek Bay
Saglek Fiord
Hebron Fiord

Figure 2. Location map of stream-sediment samples sites.

TERRAIN SCIENCES

QUATERNARY MAPPING IN THE HUMBER RIVER VALLEY (NTS 12A/13 AND 12H/4)

Martin Batterson and Spencer Vatcher
Terrain Sciences Section

The Humber River basin has long been of interest to Quaternary geologists (Figure 1). It is located between several major ice-dispersal centres on the Long Range Mountains and the Topsail Hills, as well as potential smaller late-glacial dispersal centres on Birchy Ridge and the southern Long Range Mountains. During deglaciation, the area likely contained a large pro-glacial lake and, following it's drainage, was inundated by the sea up to at least the community of Cormack. The wide range of sediment types within the Humber River valley has helped promote various resource-based activities, including agriculture and forestry, but also contributes to engineering and geotechnical difficulties, mainly as the result of thick sequences of silt/clay in the area. The aim of this project was to map the distribution of Quaternary sediments, describe their characteristics and geomorphology, map ice-flow indicators and based on these data, develop a model for the glacial and post-glacial history of the area.

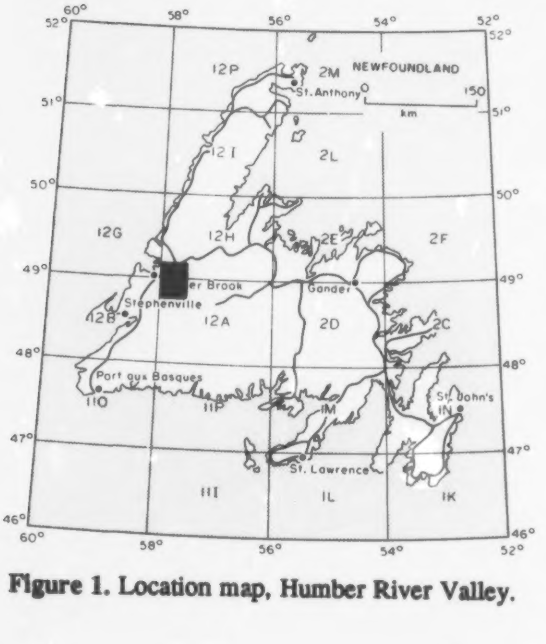

Figure 1. Location map, Humber River Valley.

Previous reconnaissance-level ice-flow mapping had suggested that the major dispersal centre that affected this area was on the Topsail Hills. This is based primarily on depositional evidence, because of the relative lack of erosional features on the soft sedimentary rocks that dominate the Humber River basin itself. More detailed work has confirmed the dominance of ice flow from the Topsail Hills. In particular, the presence of porphyritic rhyolites and peralkaline granites is indicative of transport from the Topsail Hills. This flow crossed Deer Lake and exited toward the sea through major valleys in the southern Long Range Mountain area. The draw-down of ice into the Bay of Islands is also confirmed on the basis of striations. However, striae near Pasadena and in the Humber gorge, near Corner Brook suggest that an early ice-flow event moved down Deer Lake toward the sea, exiting the inland basin either through the Humber gorge or through the Wild Cove valley. Evidence for an earlier flow is also found in the Grand Lake valley. As the Topsail Hills ice centre became dominant, ice flow was no longer topographically controlled and flowed across the Deer Lake basin.

Glacial sediments generally confirm the ice-flow patterns. Fabrics from glacial diamictons are commonly consistent with the last ice flow direction. Glacial sediment is generally absent on the uplands surrounding the Deer Lake basin, although they are thicker to the south of Corner Brook, in the Corner Brook Lake area. In the Humber River basin sediment is thicker, with boreholes in the Steady Brook area recording up to 60 m of material. Surface sediment is dominantly fluvial sand and gravel. Recent construction within the Humber gorge has exposed thick sequences of fluvial gravels, probably of Holocene age. Fluvial sediments are commonly underlain by rhythmically bedded silts and clays of probable marine origin. Over 40 m of this sediment was exposed in the boreholes at

Steady Brook. Deltas in the Corner Brook area suggest that sealevel was 50 m higher than present, during deglaciation. The presence of fans in the Wild Cove valley are likely related to this higher sea level event. However, similar fans occur in the South Brook valley near Pasadena, well above possible marine influence. These, and deltas recorded up to 135 m asl are probably related to a proglacial lake that encompassed modern Deer Lake, Grand Lake, Sandy Lake and Birchy Lake.

BEDROCK-AGGREGATE ASSESSMENT OF THE NORTHERN PENINSULA

Dan Bragg
Terrain Sciences Section

The 1991 field season consisted of an evaluation of the bedrock-aggregate potential of the Northern Peninsula (Figure 1). The assessment study was carried out to determine the quality and quantity of bedrock for possible industrial use.

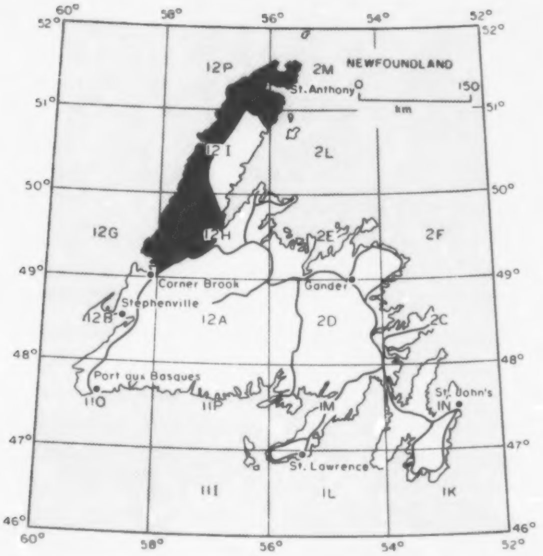
60°
58°
56°
54°
52°
52°
51°
50°
49°
48°
47°
46°
12P
2M
NEWFOUNDLAND
St. Anthony
0
150
km
12I
2L
12G
12H
2E
2F
Corner Brook
Gander
Stephenville
12B
12A
2D
2C
Port aux Basques
11O
11P
1M
St. John's
1N
St. Lawrence
11I
1L
1K

Figure 1. Location map, Northern Peninsula.

Field work consisted of traverses adjacent to the Trans-Canada and Northern Peninsula highways, and various side roads, and included thorough visits to all rock-quarries and road-cuts in the immediate area. Additional foot traverses were done in selected area along the coastline.

The rocks of the area mainly consist of limestone, dolomite, dolomitic limestone and related minor sediments of the St. George Group, Port au Port Group, Labrador Group, Cow Head Group and the Table Head Formation. Rocks (sandstone, shale, and greywacke) of the Goose Tickle Formation occur sporadically in the study area.

A total of 361 sites were visited and 245 samples were collected. Thin sections are being made of all samples and a petrographic analysis will be completed; a Petrographic number will be assigned to each sample. A selected number of samples will be chosen for further testing.

BEDROCK-AGGREGATE POTENTIAL OF THE GREAT MOSQUITO COVE AREA, BULL ARM

Dan Bragg[1] and Cyril O'Driscoll[2]
[1]Terrain Sciences Section; [2]Mineral Deposits Section

INTRODUCTION

The Great Mosquito Cove area is situated on the eastern side of Bull Arm, an inlet that extends northwestward from Trinity Bay on the isthmus of the Avalon Peninsula. The closest community is Sunnyside, which lies at the northwestern extremity of Bull Arm. A recently constructed road connects the area to the Trans-Canada Highway, 6 km to the west.

The production system for the Hibernia oilfield includes a Gravity Base Structure (GBS) and a Topsides. Construction of the GBS, assembly of the completed Topsides, and mating of the Topsides with the GBS will take place at Great Mosquito Cove. The site is presently being prepared for construction (Figure 1).

Aggregate of the highest possible quality is required in the construction of the GBS. Previous sampling in the area by the first author resulted in confirming that bedrock suitable for high-quality aggregate occurs close to Great Mosquito Cove. The present study was undertaken to geologically map the area in order to define the extent and thicknesses of suitable bedrock formations.

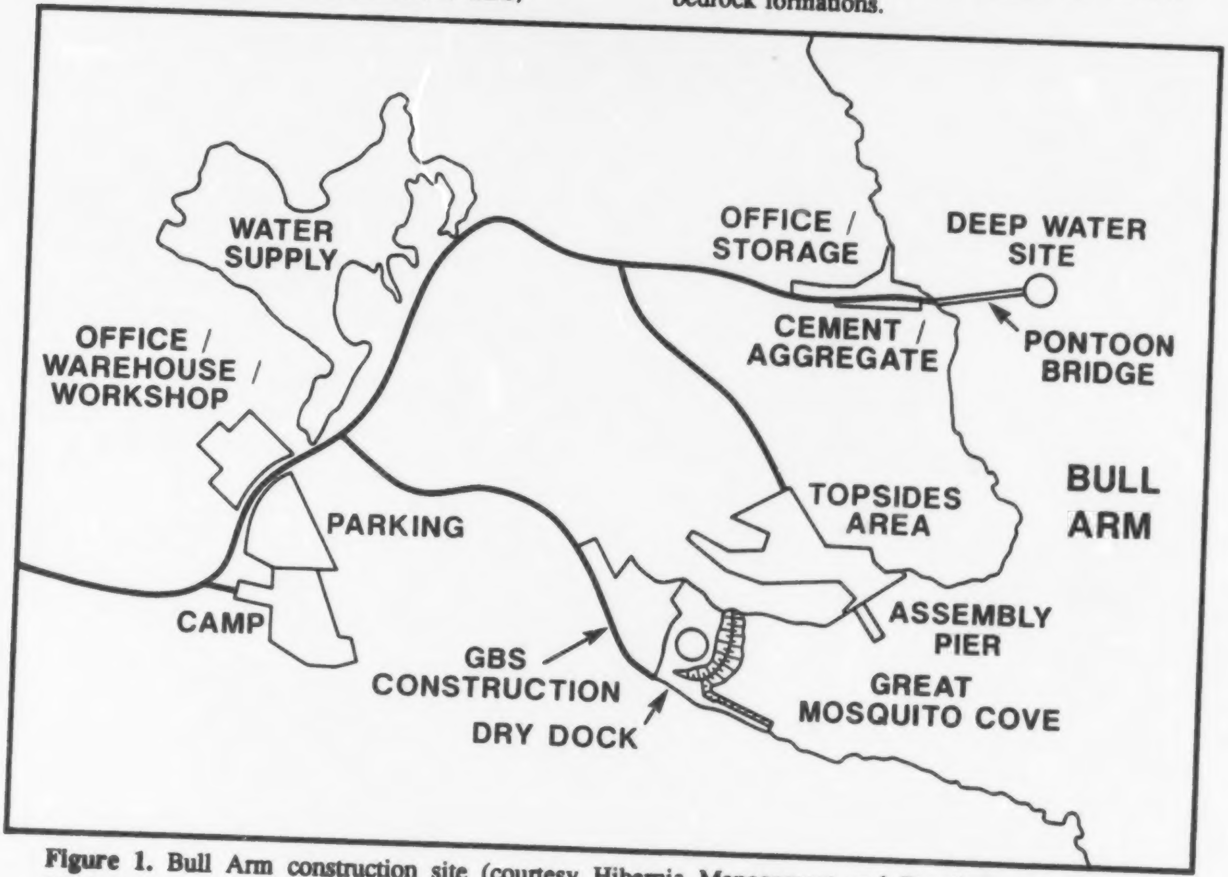
WATER SUPPLY
OFFICE / STORAGE
DEEP WATER SITE
CEMENT / AGGREGATE
PONTOON BRIDGE
OFFICE / WAREHOUSE / WORKSHOP
BULL ARM
TOPSIDES AREA
PARKING
ASSEMBLY PIER
CAMP
GBS CONSTRUCTION
GREAT MOSQUITO COVE
DRY DOCK

Figure 1. Bull Arm construction site (courtesy Hibernia Management and Development Company Limited).

GEOLOGY

The map area is underlain by a succession of late Precambrian volcanic and sedimentary rocks that are part of the Musgravetown Group, which consists of a lowest formation of mainly volcanic rocks (Bull Arm Formation) conformably overlain by a sequence of sedimentary formations.

Within the map area (Figure 2), the Bull Arm Formation consists of interbedded mafic and felsic volcanic rocks. The mafic rocks consist of dark-grey, green and purple basaltic flows, tuffs and agglomerates. In places, the rocks are vesicular and amygdaloidal. Amygdules are generally filled with calcite, epidote, chlorite or quartz. Epidote also occurs as veins and in the matrix of the basaltic tuff. The felsic rocks are purple, red, buff and light-green rhyolitic to dacitic, crystal-lithic tuffs, breccias and ash-flow tuffs. Flow banding, eutaxitic structures and zones of lithophysae are common; collapsed pumice fragments now appear as dark-green chloritic patches. Crystals in the tuffs are generally K-feldspar, albite and quartz. The volcanic rocks form belts of varying composition that strike in a northwesterly direction and dip moderately to the northeast. The thicknesses of individual units vary from a few metres to 300 m. North to northwest trending faults crosscut the area and offset some of the units.

Sedimentary rocks gradationally overlie the volcanic rocks in the northeast part of the map area and are in fault contact to the west. Red to purple, pebble to cobble conglomerates up to 70 m thick are interbedded with and overlie the upper sections of the volcanics. The conglomerates grade upward through red and buff, well-bedded sandstone and shale to very finely bedded grey and green siltstone and sandstone.

BEDROCK AGGREGATE

An estimated 270,000 to 300,000 tonnes of coarse aggregate is needed in the construction of the Gravity Base Structure. It is hoped that some if not all the coarse aggregate used would come from the Great Mosquito Cove area.

In order for a particular rock type to be considered as a high-quality aggregate for concrete use; it has to pass rigorous physical and chemical testing and procedures. Physical testing such as the Los Angeles Abrasion, Magnesium Sulfate Soundness and density; and chemical testing such as alkali - reactivity were performed on representative samples from the area. Petrographic analyses were done on all samples from the field area.

CONCLUSION

Results from the physical and chemical testing indicate that the basaltic rock types in the area are of high quality and are excellent for use in concrete. This sequence of basaltic rocks is shown as Unit 1 in Figure 2 and can be found in a number of places in sufficient quantity for immediate use.

Also as indicated in the geology of the area (Figure 2, see note) there is sufficient quantity of Unit 1 in the area for any future needs such as building more platforms, local use or export potential.

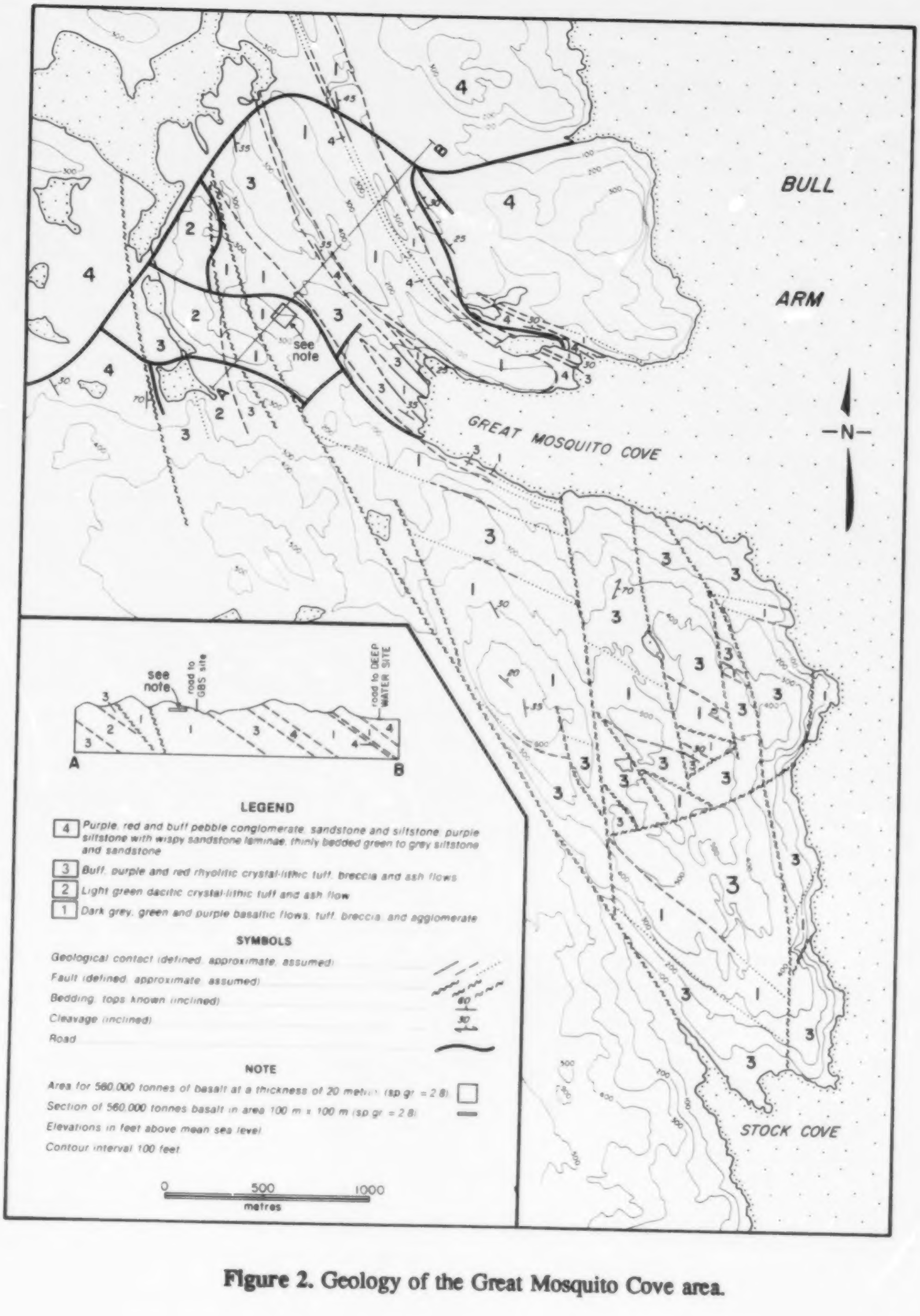
BULL
ARM
GREAT MOSQUITO COVE
STOCK COVE
N
see note
road to GBS site
road to DEEP WATER SITE
A
B
LEGEND
4 Purple, red and buff pebble conglomerate, sandstone and siltstone; purple siltstone with wispy sandstone laminae; thinly bedded green to grey siltstone and sandstone
3 Buff, purple and red rhyolitic crystal-lithic tuff, breccia and ash flows
2 Light green dacitic crystal-lithic tuff and ash flow
1 Dark grey, green and purple basaltic flows, tuff, breccia, and agglomerate
SYMBOLS
Geological contact (defined, approximate, assumed)
Fault (defined, approximate, assumed)
Bedding, tops known (inclined)
Cleavage (inclined)
Road
60
30
NOTE
Area for 560,000 tonnes of basalt at a thickness of 20 metres (sp.gr. = 2.8)
Section of 560,000 tonnes basalt in area 100 m x 100 m (sp.gr. = 2.8)
Elevations in feet above mean sea level
Contour interval 100 feet
0
500
1000
metres

Figure 2. Geology of the Great Mosquito Cove area.

DETAILED AGGREGATE-RESOURCE ASSESSMENTS INSULAR NEWFOUNDLAND

F.T. Kirby
Mineral Lands Division
Mineral Resource Management Branch

During the 1991 field season, aggregate-resource assessments were carried out in eight areas of the province and approximately 200 beach inspections were completed. The aim of the aggregate-resource assessments was to identify areas of high-quality aggregate, and protect these valuable non-renewable resources from conflicting land uses, thereby making them available to meet the long-term aggregate requirements of the region. The eight areas of study were (1) Raleigh, (2) Cow Head, (3) Bonne Bay region, (4) Port au Port Peninsula, (5) Brown's Arm, (6) Quarry Brook, (7) Little Catalina, Elliston, and Trinity, and (8) Trepassey (Figure 1).

A total of 107 aggregate samples were collected from natural and man-made exposures. Field and laboratory sieve analysis and petrographic analysis have been completed, and the data is presently being entered into the aggregate-resources database.

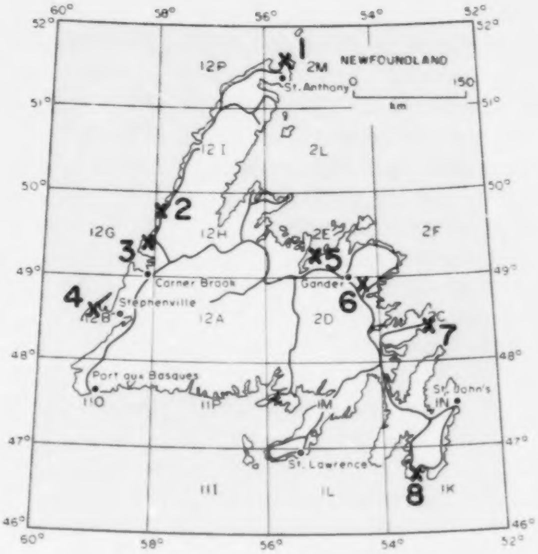

Figure 1. Location map of assessment areas.

A program of beach removal re-evaluation was begun during this years field season. This program was initiated to update the information on the approximately 730 beach files which are 14 to 16 years old. The data collected on the beach included, the exact location, the size of the beach, the composition of the beach and the amount of beach material, if any, that can be extracted. General notes on how and where the material should be removed is also included in the data gathered. Approximately 200 beach inspections were conducted over the field season and were confined to areas where field work was being conducted. Areas where beach inspections were conducted were (1) the entire Great Northern Peninsula, (2) Port au Port Peninsula including the Stephenville area, (3) the Gander Bay area from Ladle Cove to Brown's Arm, and (4) the entire Bonavista Peninsula. It is planned to complete the entire Avalon Peninsula later this year.

A computerized beach-file system is presently being developed by the Computer Unit of the Geological Survey Branch. This will facilitate planning and management of this resource by allowing rapid retrieval of files and information on beaches around the province, which are used as sources of aggregate.

QUATERNARY GEOLOGY OF THE SCHEFFERVILLE AREA, LABRADOR (NTS 23J/10 AND 23J/15)

David Liverman and Howard Vatcher
Terrain Sciences Section

The Schefferville area straddles the border between western Labrador and northeastern Quebec and has been the site of major iron ore mines. Recent research by the Department of Mines and Energy has identified the Labrador Trough as a likely site for other mineral resources (Swinden *et al.*, 1991). Studies by the Geological Survey of Canada have identified this region as an area of complex ice-flow, and possibly possessing an interesting Quaternary stratigraphic record. This, combined with the comparative cost advantages of work in a relatively developed area, led to selection of the Newfoundland part of the 23J/10 and 23J/15 NTS map sheets for study.

The objectives of the project were:

1) to map the surficial sediment cover of the area;
2) to map ice-flow indicators (striations, landforms, and clast fabric) in order to examine the ice flow history of the area;
3) to investigate the Quaternary stratigraphy exposed in vertical sections;
4) to integrate the information obtained, to interpret a Quaternary history for the area and to use this in developing a model for sediment dispersal, which would be of use to mineral exploration companies using drift exploration techniques.

PREVIOUS WORK

Klassen and Thompson (1987, 1989) identified five phases of ice movement in the Schefferville area through the mapping of erratics and striation evidence. Klassen and Thompson (1987) described a three-fold till stratigraphy in the region with a regionally recognized red to red-brown surface till overlying a grey-brown till, which in turn overlies a dark grey till. Fluvial gravels separated red and grey-brown tills, possibly indicating preservation of non-glacial sediments.

FIELD METHODS

A significant departure from field methods used by previous workers was the routine use of a sun compass. Such an instrument is required in the presence of large volumes of iron-rich rock in the Schefferville area, which disturb the local magnetic field. Use of the sun compass showed that magnetic compasses were unreliable with unpredictable variations over short distances, with deviations ranging from 0 to 60°, and averaging 10 to 20°.

ICE FLOW

Ice flow is complex, with at least three flow events clearly recorded (Figure 1). A strong flow to the southeast, parallel to bedrock strike is shown by large-scale oriented landforms drumlinoid features, crag and tails, and numerous rôches moutonées. Striae parallel to this flow trend are common, but are frequently overprinted and crosscut by striae indicating flow to the northeast. To the northeast of the map area, this later flow can be separated into two components, a northeast flow and an east-northeast flow, although the age relationship between them is not clear. Labrador Trough erratics found overlying Ashuanipi Complex bedrock to the west of the field area suggest a westward flow although no striation evidence was found. These observations can be easily accommodated in the flow models of Klassen and Thompson (1987, 1989).

Kirby (1961) reported till fabric analyses in the Schefferville area that were interpreted as showing that the dominant sediment-moving ice-flow in the area was oriented north-northwest - south-southeast. Forty fabric measurements were made in this study, of which, only three show

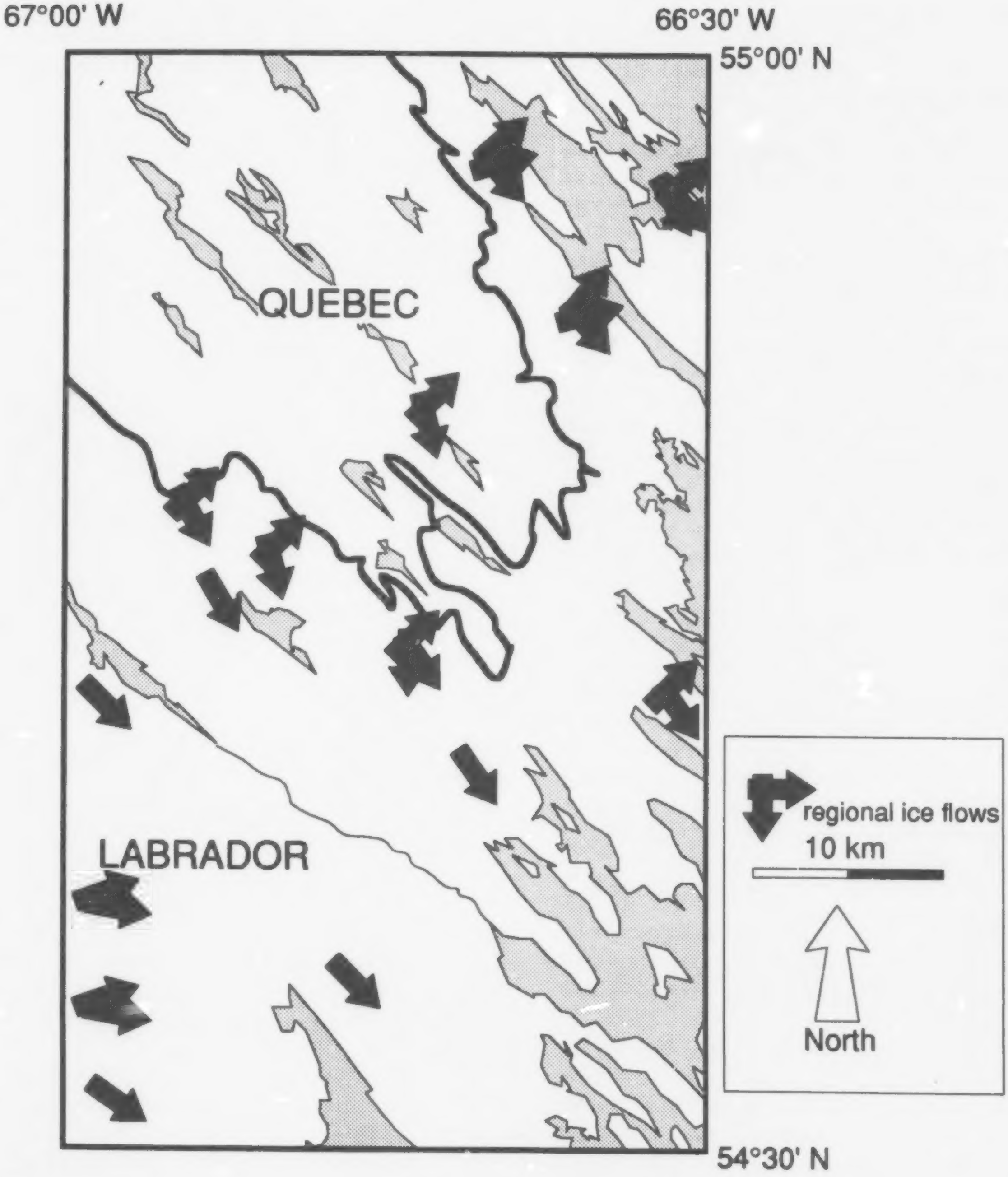
67°00' W
66°30' W
55°00' N
QUEBEC
LABRADOR
regional ice flows
10 km
North
54°30' N

Figure 1. Map of study area.

strong unimodal fabrics (using the statistical criteria outlined in Liverman *et al.*, 1990). These are all indicative of northwest - southeast flow, supporting the contention of Kirby (1961) that the later northeast flow had little effect on deposited sediment.

SURFICIAL GEOLOGY AND STRATIGRAPHY

A number of sections exposed in mine pits were examined in detail in order to examine the stratigraphy of the area. Sediment thicknesses vary widely in the area with between 0 and 40 m of unconsolidated sediment exposed. In contrast to the suggestions of Klassen and Thompson (1987), no consistent stratigraphic sequence was identified. The surface diamicton is of very variable colour, probably due to the type of local bedrock, rather than reflecting changing ice flow and provenance. The most complex sections were exposed in the Burnt Creek pit, where over 40 m of sediment is exposed and up to three diamicton units were identified. The thickest sections consist of grey, massive to stratified diamicton, having poor to moderate girdle clast fabrics, overlain by reddish-brown diamicton having stronger clast fabrics. This sequence is interpreted as showing leeside deposition, with the grey diamicton deposited by a series of debris flows into a sub-glacial cavity containing standing water, and the reddish-brown diamicton by melt-out processes. A small section at the pit margins shows three diamictons of differing colour. Clast lithological analysis shows little difference between the units, and weak fabrics suggest that the sequence was deposited by a series of superglacial debris flows, rather than discrete ice-flow events.

CONCLUSIONS/IMPLICATIONS FOR MINERAL EXPLORATION

Preliminary results suggest that the ice flow model of Klassen and Thompson (1987, 1989) can be successfully applied to this area. Clast fabric results indicate, however, that the last ice-flow events may have transported comparatively little sediment, and the early southeasterly flow dominates dispersal. No consistent stratigraphy is apparent, and the till cover is for the most part thin, and reflecting the last glacial events. Subsequent modification by meltwater during deglaciation has resulted in the formation of numerous meltwater channels, and the washing and erosion of large areas of till. This must be taken in to consideration when attempting drift prospecting methods in the area.

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GRANULAR AGGREGATE-RESOURCE ASSESSMENT IN CENTRAL NEWFOUNDLAND (NTS 2D/13 AND 14)

M.J. Ricketts and Terry Christopher
Terrain Sciences Section

During the 1991 field season, aggregate-resource mapping of sand and gravel was conducted at 1:50,000 scale, in map areas NTS 2D/13 (Grand Falls) and 2D/14 (Mount Peyton) (Figure 1). The objectives of the program were to locate, map and sample all sand, gravel and sandy-till deposits. These deposits are excellent sources of low silt-clay materials, which are necessary for use in concrete, asphalt and road construction projects. Deposit locations and aerial extent of deposits were determined by interpretation of aerial photographs. Field sampling was carried out at 0.5- to 1-km intervals in outwash deposits, and at 1.5- to 2-km intervals in till. Additional samples of granular material were taken wherever sediment-type changes were observed, where quality differences were measurably apparent, or wherever sediment of variable quality or texture occurred together that could be mined separately. Backhoe testpitting was conducted in selected areas, where other exposure types were not present, to obtain material for analyses and to determine deposit extent.

A total of 232 sites were examined and 201 samples collected in the NTS 2D/13 map area. The samples consisted of 92 gravels, 67 till, 38 sand, 2 silt and 2 clay. In the NTS 2D/14 map area, 98 sites were examined and 67 samples collected. Samples consisted of 42 till, 18 gravel, 6 sand and 1 silt.

Field sieving was done on 140 samples collected in the NTS 2D/13 map area and 50 samples collected in the NTS 2D/14 map area. Samples which were not field sieved were sands, silts, clays (samples which generally contained grain sizes finer than 16 mm in diameter), and wet, silty or compacted tills that were difficult to field sieve. Petrographic analyses have been done on all field sieved samples.

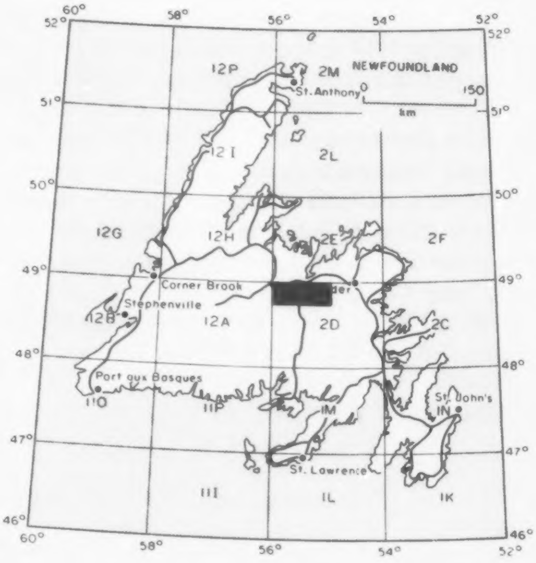

Figure 1. Location of field area.

Several sand and gravel deposits were mapped and sampled in the study area. These deposits are situated near the Exploits River, Rattling Brook, Three Brooks, Stony Brook, West Stony Brook and Sandy Brook in the NTS 2D/13 map area. In the NTS 2D/14 map area sand and gravel deposits were sampled along the Northwest Gander River, in the southwest corner of the map area. Most of this map area has extensive till cover, bog and exposed bedrock.

ICE FLOW IN WEST CENTRAL NEWFOUNDLAND, GRAND FALLS - ROBERTS ARM

David Taylor and Lloyd St. Croix
Terrain Sciences Section

INTRODUCTION AND OBJECTIVES

This project is a continuation of a project initiated in 1989 to better understand the glacial history of insular Newfoundland.

The objective of the project was to compile reconnaissance-level maps of glacial striae, at a 1:50,000 scale, of NTS map sheets 2D/13, 2E/4, 5, 12, and 12H/1 (Figure 1). Striation mapping is an effective method of obtaining a broad understanding of the general ice-flow history, over a wide, regional area.

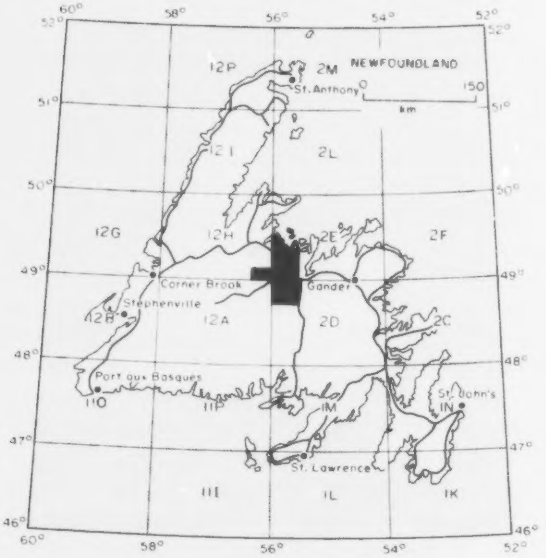

Figure 1. Map of study area.

RESULTS

Approximately 500 single and multiple direction striation sites were observed and recorded during the 1991 field season. Ice-flow direction can be determined from the morphology of the bedrock surface using such features as stoss and lee, nailheads and chattermarks. Sites that indicate more than a single ice-flow direction suggest either multiple separate flow events or possibly differing ice-flow directions within one flow event. Relative temporal relationships between the flows are indicated by crosscutting characteristics and leeside preservation.

The data collected suggests a complex ice-flow history in the area with evidence of four separate ice-flow events over all or part of the region. The first and earliest ice-flow direction trends northeast and was recorded mainly in the North and South Twin Lakes area. The second ice-flow direction was northward and can be observed in the Dawes Pond, North Twin Lake area. The third direction is a north northeast flow and can be found throughtout the study area. The fourth and most recent ice-flow direction has a eastward trend and is found sporadically throughout the central portion of the field area. This latest flow is believed to be of local origin.

IMPLICATIONS FOR DRIFT PROSPECTING

An understanding of ice-flow history of this region will aid mineral exploration when interpreting data derived from mineralized float or geochemical anomalies. In general, the most recent flow is expected to be associated with the occurrence of a geochemical anomaly or dispersal pattern. However, in this case where multiple flows have been identified, the earlier flows should be considered: 1) the earlier ice-flows of northeast and north may have initially dispersed the sediment before it was affected by the later north-northeast or eastward flow, and 2) most of the area has a thick drift cover and it is possible that a complex till stratigraphy exists over parts of the region. In such cases, provenance and thus geochemistry of each till sheet will differ, and care must be taken in sampling.

SUMMARY

This data, when combined with existing data (Taylor *et al.*, 1991) from the west, (Liverman *et al.*. 1991), (Liverman and Scott, 1990; Liverman and St. Croix, 1989), to the east (Hornbrook *et al.*, 1975) and (St. Croix and Taylor, 1991), and to the south (St. Croix and Taylor, 1990) and (Vanderveer and Sparkes, 1980), will complete reconnassience-level striation mapping for the Baie Verte Peninsula and north-central Newfoundland.

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ECONOMIC GEOLOGY

STRUCTURAL CONTROL OF THE MESOTHERMAL VEIN-TYPE RENDELL-JACKMAN GOLD DEPOSIT, SPRINGDALE PENINSULA, NEWFOUNDLAND[1,2]

B. Dubé[3], K. Lauzière[3] and D. Gaboury[4]

The Rendell-Jackman gold deposit, in northwestern Newfoundland, is one of the most significant mesothermal vein-type gold mineralization in the Canadian Appalachians. Detailed structural mapping was undertaken to unravel the structural history, determine the controls on gold mineralization and its possible relationship to the Green Bay fault.

The deposit is located within a metavolcanic sequence of mafic massive and pillowed flows, tuffs and fine grained gabbros associated with rare intercalations of sediments and felsic tuffs and by fine to medium grained felsic porphyry dykes. All but the felsic porphyry dykes have undergone at least three episodes of folding and/or shearing. The dykes were introduced after the first deformation episode.

The first episode of deformation is evidenced in the metavolcanic sequence by an S_1 planar fabric, which is relatively well developed throughout the property. It is defined by the flattening of elements such as pillows, fragments and crystals. A down-dip stretching lineation accompanies this schistosity. The second episode is responsible for the steeply plunging, upright east-west parasitic folds affecting the S_1 fabric; this produces an axial planar S_2 foliation and discrete east-west zones of brittle-ductile deformation, affecting both the metavolcanic sequence and the porphyry dykes. These discrete brittle-ductile deformation zones are particularly well developed in the flexure of the parasitic folds. Gold-bearing veins are shear vein-type and are hosted within and subparallel to these brittle-ductile S_2 deformation zones. The development of the gold bearing quartz veins is also controlled by the strong anisotropy induced by the brittle and competent felsic dykes compared to the foliated and anisotropic mafic volcanic rocks. This anisotropy has played a key role in the development of the secondary permeability, to which the mineralized veins are related.

The last ductile deformation episode produced F_3 subhorizontal chevron folds responsible for the folding of the gold mineralized veins. A east-northeast striking fault (Captain Nemo) was produced during a late brittle faulting event. Quartz vein fragments are incorporated within this cataclasite suggesting that the actual geometry of the ore zone could also be partly controlled by movement along this fault.

The formation of the mineralized veins at the Rendell-Jackman gold deposit is clearly controlled by the development of F_2 parasitic folds and by the anisotropy induced by the occurrence of felsic dykes. More work has to be done to verify the possible genetic relationship between the gold mineralization and the unexposed Green Bay fault.

Ongoing work leading to two Master's theses will better constrain the lithological and structural setting at the property and regional scales (D. Gaboury, Laval University) as well as the alteration and stable and radiogenic isotopic characteristics of the deposit (D. Ritcey, Memorial University).

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[1] Contribution to Canada - Newfoundland Corporation Agreement on Mineral Development 1990-1994; [2] Published with the authorization of Noranda Exploration Co. Ltd.; [3]Commission géologique du Canada, Centre géoscientific du Québec, 2700 rue Einstein, C.P. 7500, Sainte Foy, Québec, G1V 4C7; [4]Département de Géologie, Université Laval, Ste-Foy, Québec.

INVESTIGATION OF BEACH PLACERS, THE PORCUPINE STRAND, EASTERN LABRADOR

M. Emory-Moore[1] and J. Meyer[2]

INTRODUCTION

The Porcupine Strand, a 40 km stretch of sandy beaches, is located on the east coast of Labrador, directly south of Groswater Bay (Figure 1). The placer potential of modern and raised beach sands of the Strand area is presently being investigated by Cominco Limited, the Newfoundland Department of Mines and Energy and Centre for Cold Ocean Resources Engineering (C-CORE). Vibracoring, magnetic surveys and trench sampling of the beach sands has recently been completed. Sample analysis is underway. The objectives of the program are to outline the extent and grade of the Ti- and Fe-bearing sands and to develop a depositional model for the area.

The Porcupine Strand consists of a series of sandy beach tracts separated by low-relief rock headlands. The most prominent headland is Cape Porcupine which separates the North Strand from the South Strand (Figure 1). The slope of the beaches is generally low (< 3°) with the intertidal zone ranging from 50 to 100 m in width and the backshore varies from approximately 10 to 40 m. All beaches are cut into unconsolidated sediment bluffs composed of a basal glaciomarine silt-clay unit overlain by a proglacial deltaic sand and sand-gravel unit. Raised beaches also occur at elevations ranging from 1 to 80 m throughout the Porcupine Strand lowlands.

The placer potential of the Porcupine Strand beaches was first investigated by Emory-Moore and Meyer (1991). Based on a metre thickness, an estimated 33,600 tonnes of iron-titanium concentrate and 9,150 tonnes of garnet concentrate were delineated over one kilometre of the beach; neither the thickness nor lateral extent of the mineralized sand was not established.

METHODS OF SAMPLING AND ANALYSIS

Fifty-one holes were drilled in the modern beach complexes of the Porcupine Strand using a vibra-core drill. In all cases, drill penetration was limited to 1 to 2 m due to the presence of gravel and clay horizons and in some areas, frozen ground. A sample weighing from 1 to 5 kg was recovered at each site.

Forty-seven channel samples were collected from trenches in the modern beach complexes of the Strand and, where possible, exposed sections of raised beach terraces. Near Beaver Brook several beach profiles were measured and detailed sampling of each undertaken.

Twelve graduated sediment rods were driven into the beach at selected sites and will be used to monitor net sediment erosion and/or deposition. A loosely fitting washer was slipped over the rod and placed on the surface of the beach. At the end of the observation period, probably late November, the distance from the washer to the original sand surface, as measured on the graduated rod, will provide a measure of net erosion. The distance from the washer to the final sand surface will indicate the amount of subsequent backfilling.

Magnetic surveys of the modern beach and raised beach terraces were undertaken using an Omni magnetometer. A total of 49 transects were completed, 10 of which included repeated surveys using different sensor heights.

A 30 gram split of all samples has been submitted to the Newfoundland Department of Mines and Energy for geochemical analysis. Detailed textural and mineralogical analysis of

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[1]C-CORE, Memorial University of Newfoundland, St. John's, Newfoundland; [2]Mineral Deposits Section

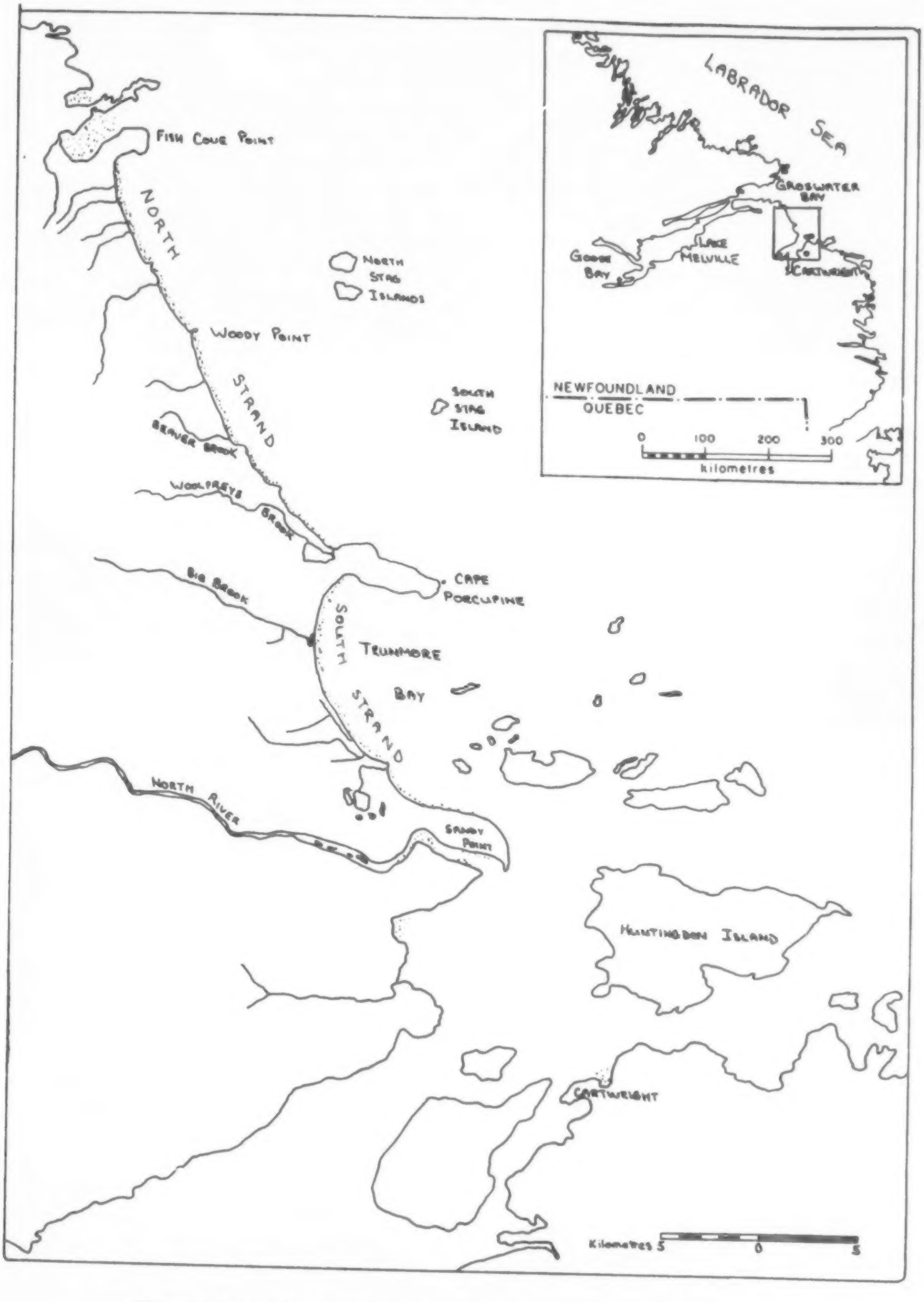
LABRADOR SEA
GROSWATER BAY
GOOSE BAY
LAKE MELVILLE
CARTWRIGHT
NEWFOUNDLAND
QUEBEC
0
100
200
300
kilometres
FISH COVE POINT
NORTH STRAND
NORTH STAG ISLANDS
WOODY POINT
SOUTH STAG ISLAND
BEAVER BROOK
WOOLFREYS BROOK
BIG BROOK
CAPE PORCUPINE
SOUTH STRAND
TRUNMORE BAY
NORTH RIVER
SANDY POINT
HUNTINGDON ISLAND
CARTWRIGHT
Kilometres 5
0
5

Figure 1. Location map for the Porcupine Strand, eastern Labrador.

select samples will be undertaken as part of two undergraduate Honours thesis at Memorial University.

DISCUSSION

The heavy-mineral content of the South Strand beaches (both modern and raised) was found to be far less than that of the North Strand beaches and hence the following observations are limited to the latter.

Beach terraces occurring at elevations of greater than 10 to 15 m are characterized by large and small trough and planar tabular cross beds, isolated scour fills, low-angle inclined stratification, and exhibit isolated, thin laminations (1 to 3 mm) of heavy minerals. They are derived primarily from reworking and redistribution of outwash sediments and do not appear to hold significant placer potential.

Beach terraces occurring at elevations of lower than 10 to 15 m are characterized by subhorizontal planar beds of quartzofeldspathic minerals interbedded with well-sorted heavy-mineral beds. Although the lower terraces are quite extensively mineralized, they have been partially or completely eroded in many areas. Remnants of the terraces are, however, well preserved around brook inlets and in the lee of offshore islands (e.g., Woody Point; see Figure 1).

The marked differences between the mineralized lower terraces and the more barren upper terraces are related to changes in coastal dynamics and sediment supply with ice recession and the regressing sea; the mineralized terraces formed during a period of slow emergence and limited sediment supply whereas the upper terraces were deposited under conditions of a high sediment supply (principally through glacial meltout) and rapid emergence.

The distribution of heavy-mineral sands on the modern beach is closely related to that of the mineralized terraces. During high-energy storm events the mineralized terraces are eroded and the light mineral grains are selectively removed from the backshore sediment suite. This phenomena produces planar subhorizontal strata that are up to 3 cm thick and contain 80 to 90 weight percent heavy minerals. The concentrations of heavy minerals is highest at the base of eroding bluffs and tapers off significantly within the intertidal zone. The zone of mineralization is generally less than 2 m thick and is underlain by glaciomarine silts and clay.

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METALLOGENIC STUDY OF GOLD MINERALIZATION IN THE EASTERN DUNNAGE ZONE, CENTRAL NEWFOUNDLAND

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Mineral Deposits Section

INTRODUCTION

During the 1991 field season, work documenting the nature and setting of gold mineralization hosted by rocks of the eastern Dunnage Zone continued along the central portion of the zone extending from Glenwood southwest to Great Rattling Brook (Figure 1). This work involved detailed mapping, sampling and diamond drill-core logging. Work was also conducted on a number of small gold occurrences located in the eastern Notre Dame Bay area and reconnaissance mapping was carried out along the woods road in the Salmon Pond area.

GOLD MINERALIZATION

The following styles of gold mineralization were documented:

1) Gold is associated with both intensely silicified granitic (Powderhouse Cove, Hornet and Middle Ridge) and deformed gabbroic (Porterville, Brinks Pond and Duder Lake) rocks. An M.Sc. thesis documenting the setting, style, and alteration related to gold mineralization at the Duder Lake prospect has been started by Rod Churchill (MUN).

2) Gold-bearing quartz veins are hosted by brittlely deformed greywacke and shale (Knob, LBNL and Goose).

3) Gold occurs within narrow, quartz-veined, sericitized and silicified shears within the Mount Peyton intrusive suite (Hurricane and Corsair), and

4) Silicified and quartz veined, locally hematized zones within complexly deformed ultramafic rocks of the Great Bend (Chiouk Brook, Lizard Pond, Spud Pond and Breccia Pond) and Pipestone Pond (South Great Rattling Brook) complexes.

Significant mineralized and/or altered float were examined at two localities:

1) Gold-bearing quartz boulders (Moosehead), located near the western contact between the Botwood Group and the Mount Peyton intrusive suite. The source of these boulders appear to be Fe-carbonate altered Botwood Group sandstone, and

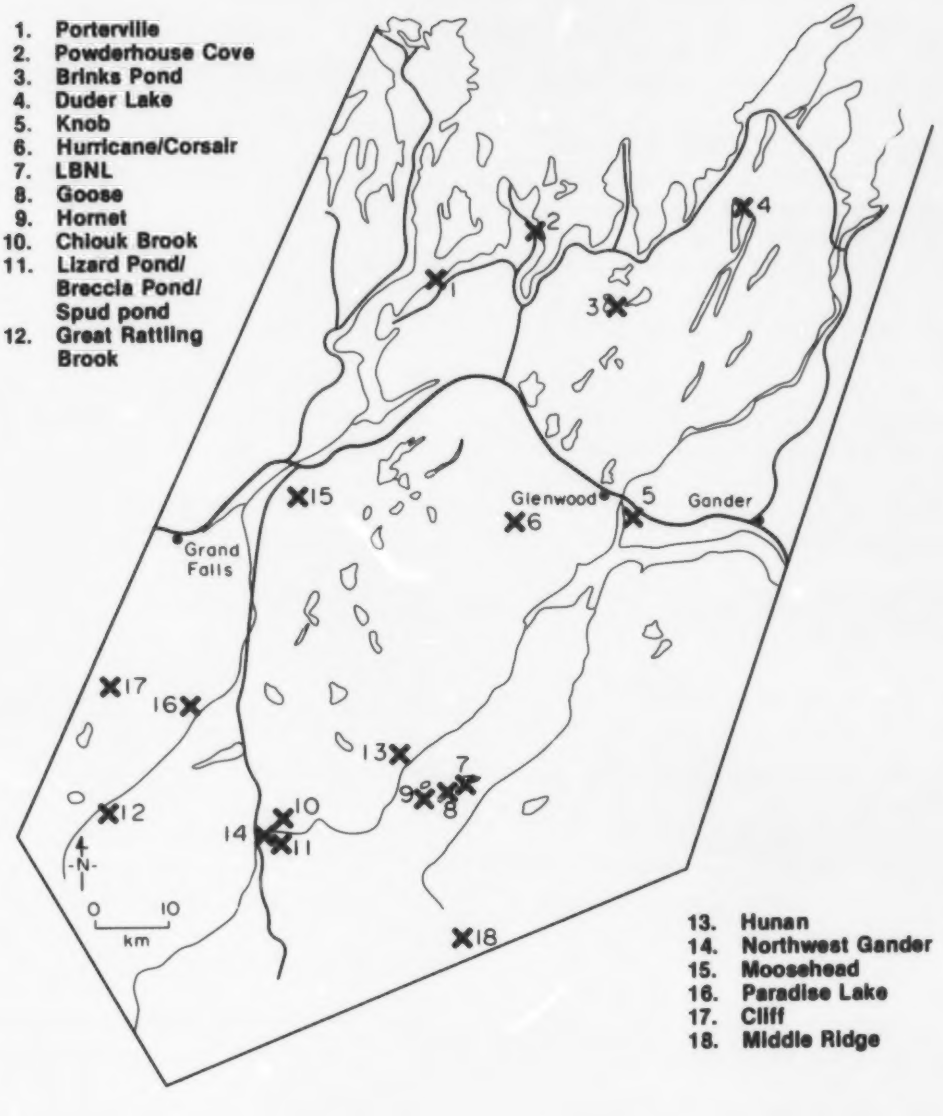
2) Spectacular quartz-breccia and chalcedonic float with angular fragments of Botwood Group sandstone (?) were discovered along the Paradise Lake road, south of Grand Falls. These breccias, which are similar to those documented from the Aztec prospect (Evans, 1991), indicate that epithermal style alteration and gold mineralization may occur within the Botwood Group.

OTHER STYLES OF MINERALIZATION

During the course of this study, significant, possibly gold-related mineralization was documented at three localities:

1) Antimony mineralization associated with brittlely deformed greywacke (Hunan).

2) Disseminated pyrite and arsenopyrite within silicified and sericitized, locally quartz-veined, flow-banded rhyolite (Cliff) discovered by Battle Mountain (Canada) Inc. in 1989. This showing occurs within the Silurian Stony Lake volcanics and is the first significant mineralization to be reported from the area.


1. Porterville
2. Powderhouse Cove
3. Brinks Pond
4. Duder Lake
5. Knob
6. Hurricane/Corsair
7. LBNL
8. Goose
9. Hornet
10. Chiouk Brook
11. Lizard Pond/ Breccia Pond/ Spud pond
12. Great Rattling Brook
13. Hunan
14. Northwest Gander
15. Moosehead
16. Paradise Lake
17. Cliff
18. Middle Ridge
Glenwood
Gander
Grand Falls
N
0
10
km
1
2
3
4
5
6
7
8
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12
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16
17
18

Figure 1. Location map showing prospects, showings and areas of mineralized float visited during this field season.

3) Massive sulphide mineralization and coarse arsenopyrite-bearing quartz veins hosted by altered ultramafic rocks (Northwest Gander road) was discovered by BP Resources Canada Ltd. in 1990. The showing, which is exposed in a small trench, is marked by massive sulphide float scattered approximately 30 metres along an old logging road.

PRELIMINARY CONCLUSIONS

Gold mineralization within the central-eastern Dunnage Zone, as in the northeastern Dunnage Zone, is epigenetic and structurally controlled. Host rocks to the mineralization vary significantly in type and age, but are similar in that they act as either brittle or chemically favourable gold traps located along regionally extensive, possibly deep-seated structures. Sericitization, silicification, pyrite, abundant arsenopyrite and anomalous antimony are common to the majority of showings.

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THE PORT AUX BASQUES GNEISS - A POTENTIAL SOURCE OF HIGH-ALUMINUM REFRACTORY MINERALS OF THE SILLIMANITE GROUP (KYANITE, SILLIMANITE AND ANDALUSITE)

Ambrose F. Howse
Mineral Deposits Section

INTRODUCTION

During the 1991 field season, a preliminary assessment of industrial minerals of the Port aux Basques gneiss was carried out. The survey focussed on occurrences of kyanite, a nonmetallic mineral, which along with sillimanite and andalusite, share the composition Al_2SiO_5, and are collectively known as the sillimanite group of minerals. All three are industrially important because their product of calcination, mullite ($Al_6Si_2O_{13}$), is highly refractory and in demand wherever high-temperature processes such as smelting of metals and the making of glass are carried on. Refractory applications consume about 90 percent of kyanite production. The remaining 10 percent finds use in numerous products such as ceramic linings, precision castings, and brake shoes and discs. It is also used in the aerospace industry as an insulating material in space capsules and jet aircraft engines.

Garnet, which is ubiquitous in the Port au Basque gneiss, is invariably associated with occurrences of kyanite. It is becoming popular as an abrasive because of environmental constraints against its competitors. For example, it contains no free silica and thus avoids the silicosis problem associated with silica in sand blasting. High quality garnet is used for grinding and lapping glass, ceramics and other materials. Lower quality material is used for cleaning and conditioning aluminum and other soft metals.

GENERAL GEOLOGY

The Port aux Basques gneiss is located southeast of the Cape Ray Fault and dominates the geology in the region around Port aux Basques. It consists of a well-banded complex of leucocratic and melanocratic units intruded by granitic rocks. The bands, which occur on scales ranging from centimetres to metres, strike northeast and dip steeply to the southeast. The melanocratic units consist of dark-green hornblende-rich rocks and epidosite. The leucocratic bands, which vary in composition from quartz - feldspar to muscovite-biotite-garnet schist, are of commercial interest as a potential source of kyanite and sillimanite.

The 1991 investigation focussed mainly on the kyanite-bearing mica garnet schist. Kyanite mineralization occurs in two distinct modes, as large blue crystals and crystal aggregates up to 10 cm in length, usually wrapped around the rims of quartz pods, and as small thin-bladed crystals (up to 2 cm long), which along with biotite and muscovite, form the schistose fabric of the rock. Both types of mineralization often occur together but the latter (disseminated) type appears to be more significant because it comprises a greater percentage of the rock (locally up to 20 percent).

RESULTS

Several significant zones of kyanite-enriched mica garnet schist were identified along a northeast trending belt that extends across Mouse Island and inland from Grand Bay (Figure 1). On Mouse Island, a line of knobby hills and ridges contain spectacular occurrences of coarsely crystalline kyanite along with the disseminated type of mineralization. Due to the discontinuous nature of the outcrops, it was difficult to accurately gauge the extent of the kyanite, although zones of up to 20-m-strike-length were observed with widths up to 5 m.

Similar zones of kyanite were noted inland from Grand Bay. The most extensive mineralization is located about 2 km from the coast and is traceable, although discontinuously, for at least 1500 m along the strike. In one of

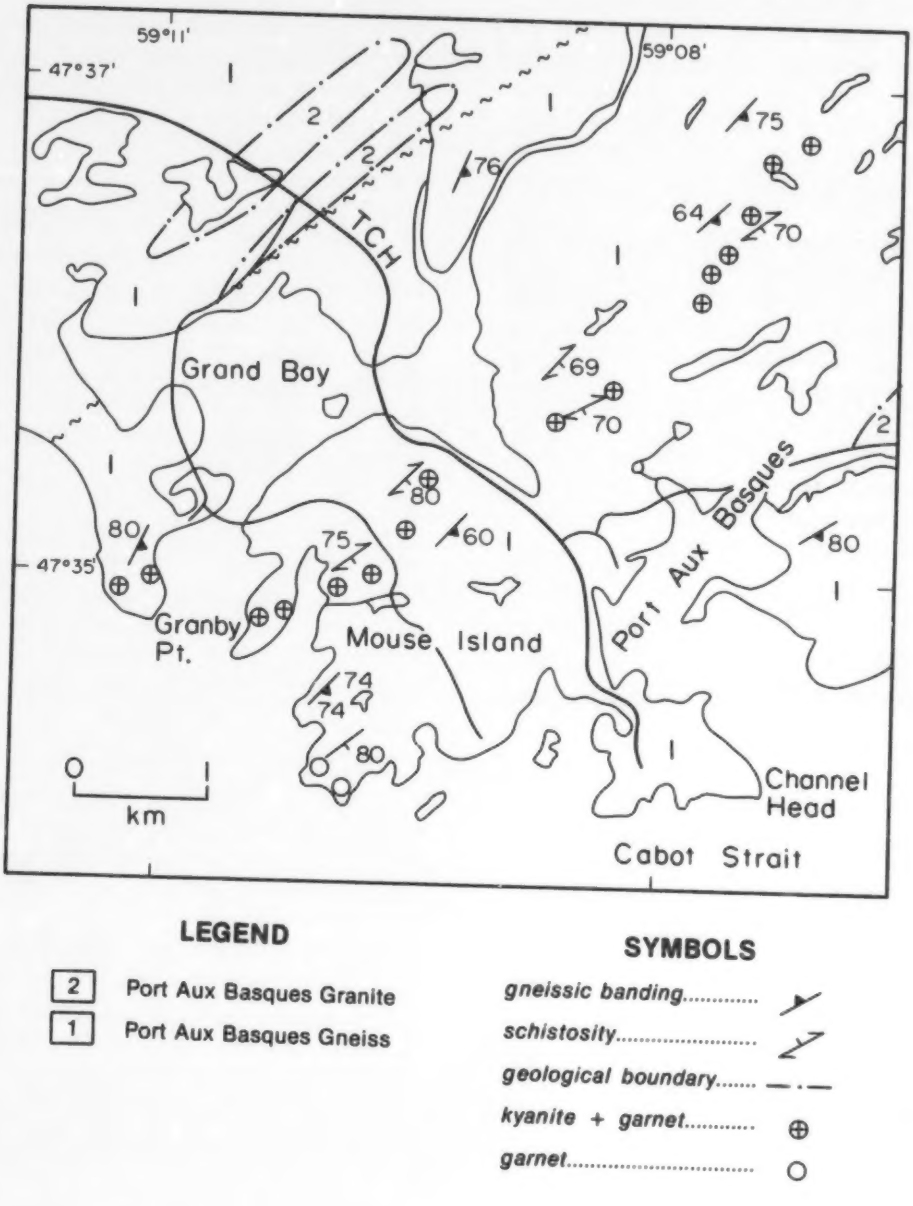
59°11'
47°37'
59°08'
47°35'
1
2
TCH
Grand Bay
Granby Pt.
Mouse Island
Port Aux Basques
Channel Head
Cabot Strait
0
1
km
75
76
64
70
69
70
80
60
80
75
80
74
74
80
LEGEND
2 Port Aux Basques Granite
1 Port Aux Basques Gneiss
SYMBOLS
gneissic banding
schistosity
geological boundary
kyanite + garnet
garnet

Figure 1. Kyanite occurrences in the Port aux Basques region. Geology after Brown (1977).

the best occurrences, small bladed kyanite crystals comprise an estimated 15 percent of the host garnet-mica schist and extends along a surface width of 8 m and a strike length of 30 m. In the same outcrop, coarse books of muscovite 6 cm across were observed in quartz pods in the schist. Taken alone, the mica is of little significance, but when considered along with kyanite and garnet it might add to the commercial potential of the zone.

Garnets were observed throughout the Port aux Basques gneiss but the largest (up to 1.5 cm) and best shaped crystals were noted in biotite-rich schist bands. There, the garnets are a deep red and are euhedral to subhedral in outline. The biotite-rich bands, however, appear to be lacking in width (<50 cm noted) but the proportion of garnets in the rock is high. Garnets were almost invariably noted with kyanite mineralization but they are generally less than 5 mm in diameter and are deformed.

SUMMARY

Bands of mica-garnet schist in the Port aux Basques gneiss are good prospective units for high-aluminum refractory minerals of the sillimanite group (mainly kyanite). Locally, kyanite content in the rock ranges up to 20 percent. It occurs mainly in two modes, as large blue crystals associated with white quartz pods in the schist, and as smaller bladed crystals that form part of the schist. The latter type is more significant because it is more pervasive. Garnets are ubiquitous in the Port aux Basques gneiss and are invariably associated with kyanite, a fact which may enhance the commercial potential of the kyanite zones.

Several of the kyanite showings were sampled for chemical analyses including metallurgical tests. The results will be released as they become available.

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THE STOG'ER TIGHT GOLD DEPOSIT: A STRUCTURALLY AND LITHOLOGICALLY CONTROLLED SILL-HOSTED GOLD DEPOSIT IN THE BAIE VERTE PENINSULA, NEWFOUNDLAND[1,2]

Donna Kirkwood[3] and Benoit Dubé[4]

The Stog'er Tight gold deposit is the best example of a mesothermal altered wallrock-type of gold mineralization in the Canadian Appalachians. Detailed structural mapping has been done to define the structural history of the area, the controls on gold mineralization and its relationship to the major fault zones. The deposit is hosted in differentiated gabbroic sills within the cover sequence of the Point Rousse Complex. Three phases of deformation affected the rocks of the area. The first phase of deformation (D_1) consisted of an intense ductile shearing which produced the regional foliation (S_1). The development of the quartz - carbonate veins and associated alteration and gold mineralization is ascribed to a late (post-ductile) increment of the D_1 event. The second event (D_2) produced south-verging asymmetric folds (F_2), ductile-brittle high-angle faults and a fracture cleavage. Late north-northeast- to northeast-trending, broad open folds (F_3) refold older structures.

The Stog'er Tight gold deposit is a Paleozoic example of a subclass of mesothermal gold deposit, similar to those hosted in layered gabbroic sills. They are common worldwide and some of the best examples are the Archean gold deposits enclosed in the Golden Mile dolerite sill at Kalgoorlie in Australia (Phillips, 1986), those enclosed within the Bourbeau sill in Abitibi (Dubé *et al.*, 1989; Dubé, 1990) and the San Antonio gold deposit in Manitoba (Poulsen *et al.*, 1986 and Ames *et al.*, 1991). An analogy with the San Antonio deposit, both on the alteration and geometry point of view, is particularly strong.

The genesis of the Stog'er Tight deposit, as for this subclass of mesothermal gold deposits, is clearly controlled by the strong mechanical and chemical influence of the hosted gabbroic sill on the development of the structural permeability allowing circulation of the hydrothermal fluid, development of the hydrothermal alteration and destabilization of the bisulphide complex carrying gold by reaction between the iron-rich content of the sill and the sulphur vehiculated by the fluid.

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DIMENSIONAL STONE: 1991 UPDATE

Jamie Meyer
Mineral Deposits Section

Newfoundland and Labrador possess a wide variety of granite, granite gneisses, marble, sandstone, and slate, spanning a wide range of geological ages, and having a considerable variety of colours, types and textures. Exploration and assessment of the dimension stone potential of the province is ongoing, both by government geologists, and by prospectors and future developers.

LABRADOR

The most advanced dimension stone project in the province is located at tidewater in Ten Mile Bay, on the northern Labrador coast, approximately 10 km south of Nain (Figure 1). This extremely large deposit consists of a very uniform, medium-grained, light grey anorthosite, with up to 20 percent of the labradorite crystals showing flashes of blue on a cut surface. The deposit is being developed by the Labrador Inuit Development Corporation (LIDC), with the help of an Italian firm, who will also market the stone. A 50-m-long face, was opened up this past summer, and limited block production is expected this fall. A 10 tonne block sent to Italy last fall, was cut and polished, and received a very favourable response in Europe.

NEWFOUNDLAND

Granite

In central Newfoundland, exploration has focussed on the Mt. Peyton gabbro, the Deadman's Bay Granite and the Pass Island Granite. As part of a 1987 Federal/Provincial funded demonstration project, (Agricola Mineralia, 1988), small blocks were obtained from these three intrusions, and tiles (55 cm by 55 cm) were cut and polished for display.

The Mt. Peyton batholith consists of a black to green pyroxene gabbro, which has been intruded by a later, pink granite phase. An assessment of the gabbro carried out by the Department of Mines and Energy identified several areas with potential for dimension stone, (Tomlin, 1982), one of which was selected for a small trial quarry under the 1987 demonstration project. A second area around Borney Lake, was investigated in more detail by the Mount Peyton Granite Company. The company, with some financial assistance from ACOA, opened up a trial quarry in 1990 and produced rough blocks up to 3 cubic metres in size. There is considerable interest in this "black granite" for monumental and facing stone, and for the tile market.

The Pass Island granite, on the Hermitage Peninsula, is a medium-grained, pink to red granite, that was also quarried by the Mount Peyton Granite Company in 1990. A quarry was opened up adjacent to the main road, several kilometres northeast of Seal Cove, in an attractive pink phase of the granite. Blocks up to 5 cubic metres were quarried, with good production rates and low waste. The red phases of this granite are currently being evaluated.

The Deadman's Bay Granite, in the northeastern part of the island, is a megacrystic pink granite, with flesh-coloured, euhedral feldspar crystals up to 10 cm long. Surveys and demonstration projects carried out in the Lumsden area have shown that there is potential for commercial-sized blocks, and independent marketing agents have received very favourable responses from buyers in the U.S.A. and Europe. This granite was selected by architects to be used on the interior walls of the new Earth Sciences building at Memorial University in St. John's, under a second federal/provincial funded demonstration project.

There are many other granite prospects, not only in central Newfoundland, but also in eastern and western parts of the island. Some of these granites were quarried over a hundred

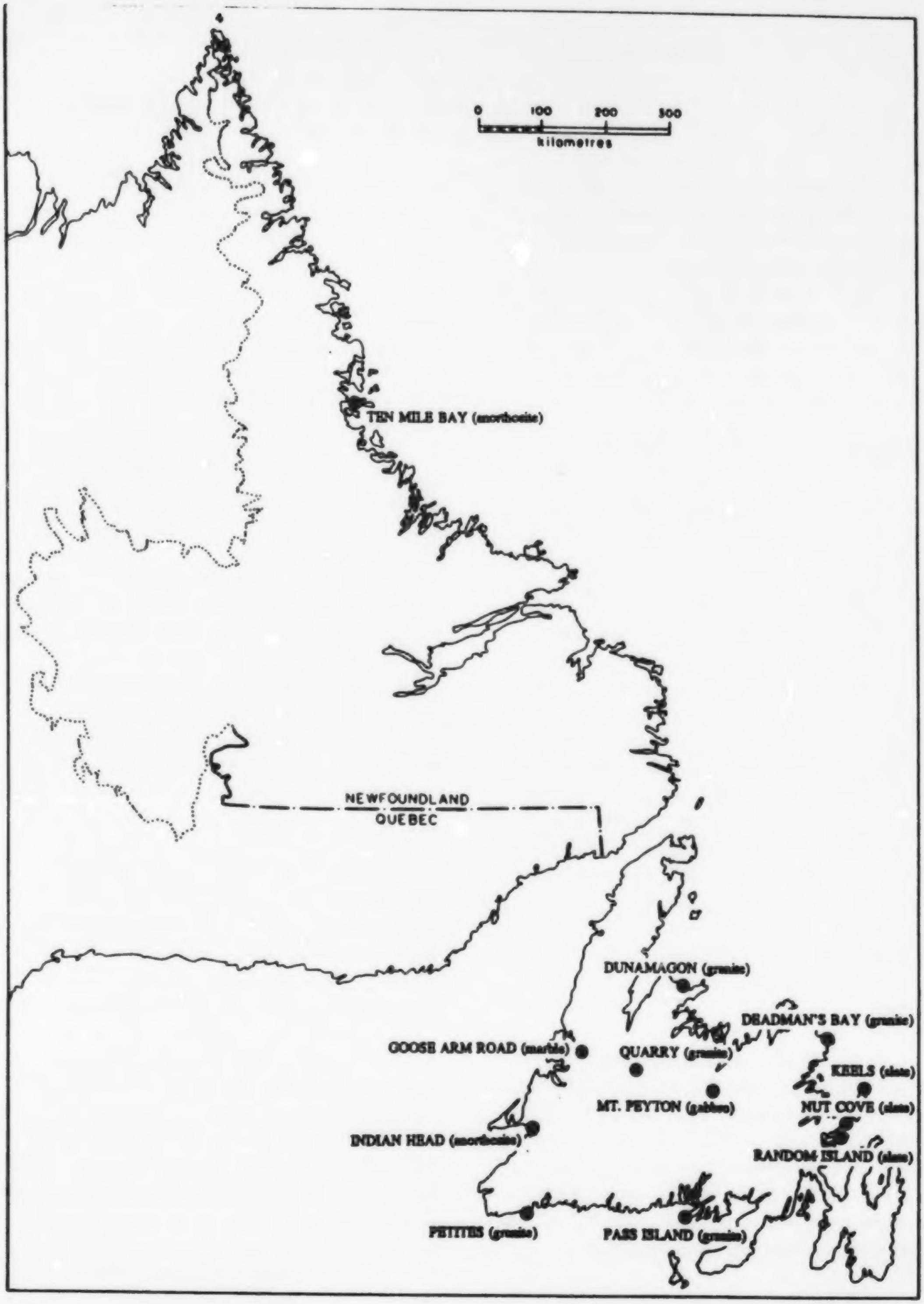
0
100
200
300
kilometres
TEN MILE BAY (anorthosite)
NEWFOUNDLAND
QUEBEC
DUNAMAGON (granite)
DEADMAN'S BAY (granite)
GOOSE ARM ROAD (marble)
QUARRY (granite)
KEELS (slate)
MT. PEYTON (gabbro)
NUT COVE (slate)
INDIAN HEAD (anorthosite)
RANDOM ISLAND (slate)
PETITES (granite)
PASS ISLAND (granite)

Figure 1. Dimensional stone deposits and prospects in Newfoundland and Labrador.

years ago. The Petites Granite prospect, on the Southwest coast, was quarried in the late 1800's, and granite blocks were shipped from the town of Petites to St. John's, for use as a structural building stone, (i.e., in the St John's courthouse). The stone is a light to dark brownish-pink, medium- to coarse- grained potassium feldspar granite. The Indian Head prospect, located at Port Harmon, near Stephenville, is a green and white, altered anorthosite which was previously quarried for armour stone. Numerous granite prospects exist in the Topsails Igneous Complex, and can be accessed by the old railway line; e.g., near the town of Quarry, a greenish-white, medium-grained granite was quarried for bridge abutments, and used in the construction of the St. John's train station. On the Baie Verte Peninsula, near the town of Woodstock, the orange-pink, slightly foliated, medium-grained Dunamagon granite outcrops on the west side of the harbour. This granite prospect occurs in moderately dipping sheets which are up to, and sometimes more than 1 m thick, but which can be up to 10 m in either of the other two directions.

Marble

New interest in the province's marble potential has been generated by the work being carried out on Len Pye's Goose Arm Road deposit. The deposit consists of a mountain of recrystallized St. George and Table Head group rocks, 2.5 km by 5.0 km in area. Stripping of overburden by Mr. Pye, has exposed a wide variety of colours, including a mottled blue-grey, grey and white banded, a mottled peach, pink with white and green banding, and a large area of grey with black stylolites. The deposit has been mapped by Ian Knight of the Dept. of Mines and Energy, and an assessment program, including a small amount of drilling, was carried out this past summer by an Italian consulting geologist. While this deposit will hopefully be brought into production in the near future, work is also being carried out on other marble prospects on the West Coast.

Slate

Eastern Newfoundland possesses several areas of excellent quality slate located at tidewater, and many of which were worked in the late 1800's. Most of the deposits contain top quality green and purple slate, with smaller amounts of red and grey. Currently,there are several new benches being developed at the Nut Cove slate quarry in Trinity Bay, which has only seen small-scale production since it was reactivated in 1986. Preliminary assessment work was carried out in 1990 on the Keels deposit in Bonavista Bay, and an access road was constructed. A 6-km-long slate belt on Random Island, was recently mapped by its owner, John Tuach. Reserves of the north-trending syncline have been estimated at over 350 million tonnes of slate, with the potential to produce roofing and architectural slate products.

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RARE-METAL POTENTIAL IN NEWFOUNDLAND AND LABRADOR

Randy R. Miller
Mineral Deposits Section

Recent work on the rare-metal mineralization in the Strange Lake Zr-Y-Nb-Be-REE deposit (Miller, 1986) and in the Letitia Lake Nb-Be±Y showings (Miller, 1987) has lead to the formulation of a model for rare-metal mineralization associated with felsic rocks (Miller, 1988); the model has been further supported by more recent work (Miller, 1990). This model will be applied to felsic settings in Labrador and insular Newfoundland during a four year research program, to evaluate the rare-metal potential and to encourage exploration activity for rare metals in the province. The first field season (1990) resulted in the sampling and evaluation of several targets in insular Newfoundland (Miller, 1991). This past summer, the second field season of the project, focussed on the Topsails Igneous Suite in insular Newfoundland and the Flowers River volcanic suite in Labrador.

Targets include felsic volcanic rocks and related intrusive rocks from complexes, which are peralkaline, have peralkaline affinities (e.g., high values of Zr, Nb, U, F, REE) or are associated with peralkaline rocks. Complexes or suites targeted for sampling this summer (Figures 1 and 2) included: Topsails igneous suite, including felsic volcanic rocks of the Sheffield Lake area and the Little Pond Brook area, the Kings Point Complex, the Flowers River volcanic suite and the Upper Aillik Group. Work in the Kings Point Complex consisted of a follow-up of favourable areas outlined in the 1990 field season. The Topsails peralkaline granite, the Sheffield Lake volcanic rocks and the Little Pond Brook volcanic rocks were sampled and reconnaissance mapped. The volcanic rocks of the Flowers River suite were extensively sampled and mapped to evaluate their rare-metal potential and to determine the volcanic stratigraphy. The Upper

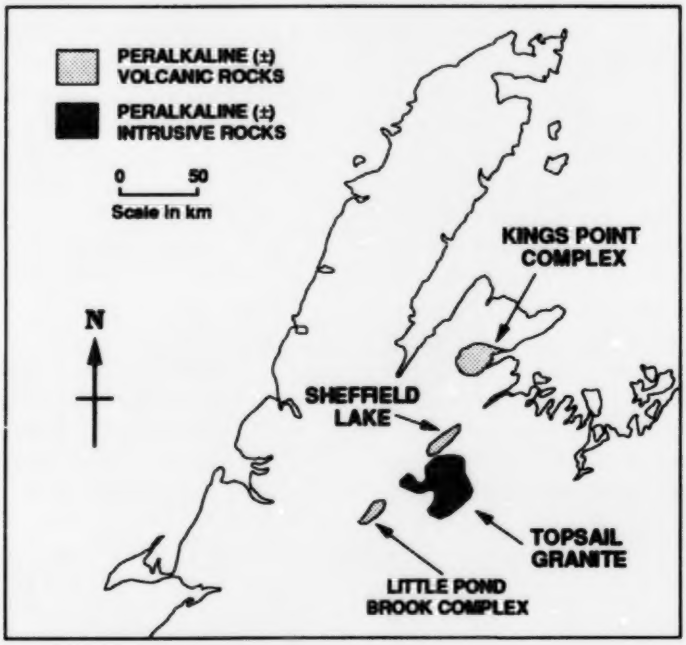
PERALKALINE (±) VOLCANIC ROCKS
PERALKALINE (±) INTRUSIVE ROCKS
0
50
Scale in km
N
KINGS POINT COMPLEX
SHEFFIELD LAKE
TOPSAIL GRANITE
LITTLE POND BROOK COMPLEX

Figure 1. Study area in the Baie Verte Peninsula and Topsail area.

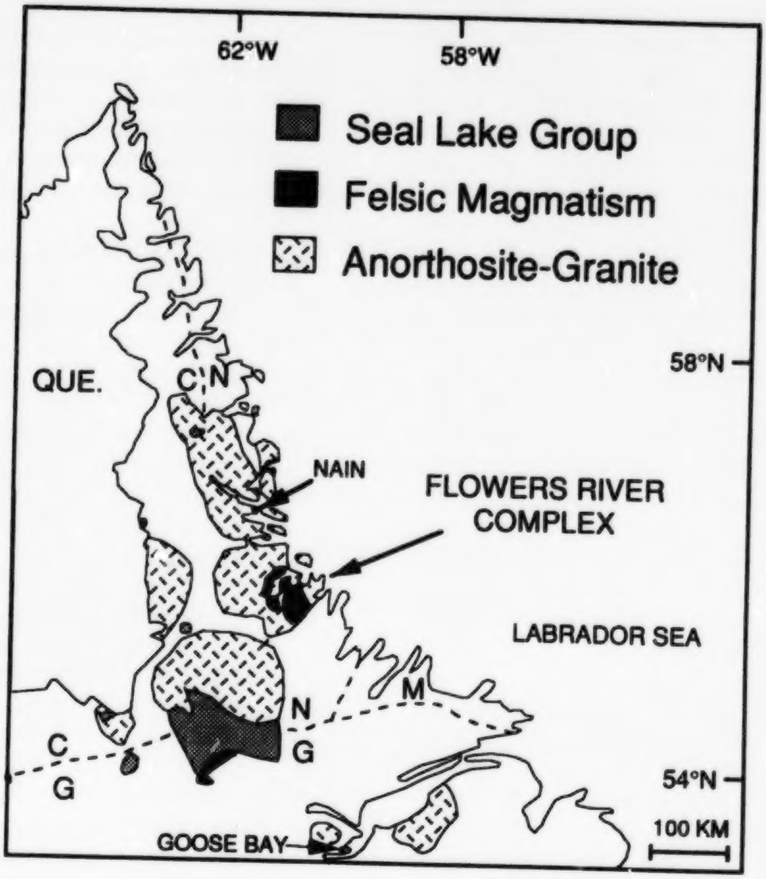
62°W
58°W
Seal Lake Group
Felsic Magmatism
Anorthosite-Granite
QUE.
C N
58°N
NAIN
FLOWERS RIVER
COMPLEX
LABRADOR SEA
M
N
G
C
G
54°N
100 KM
GOOSE BAY

Figure 2. Study area in Labrador

Aillik Group was reconnaissance sampled in a few trial locations.

The sampled areas can be characterized as follows:

Kings Point Complex - A felsic subvolcanic - volcanic complex, which consists of peralkaline and non-peralkaline trace-element enriched granites, porphyries, porphyritic syenite, ignimbrites, lava flows and breccias. The follow-up work was carried out in a zone of peralkaline ignimbrites and flows, which occurs at or near the contact between peralkaline porphyries and non-peralkaline ignimbrites.

Topsails peralkaline granite - This granite occurs as a pluton of riebeckite-bearing medium-grained peralkaline granite, along with some finer grained and quartz - feldspar porphyritic phases.

Sheffield Lake peralkaline volcanic rocks - These rocks occur as several separate bodies of quartz - feldspar and quartz - feldspar - amphibole porphyries and syenites having minor amphibole aggregate (oikocrystic) aphanitic flows.

Little Pond Brook volcanic suite - This suite occurs as a 10 x 10 km complex of feldspar and feldspar - quartz -

amphibole porphyries having minor ignimbrites and flow breccias.

Flowers River volcanic suite - This suite contains a large variety of felsic porphyries including feldspar - quartz porphyry, quartz porphyry, feldspar - quartz - amphibole porphyry and quartz - mafic porphyry. Other distinct felsic units, consisting of aphyric flows, quartz-poor flows, breccias and ignimbritic flows are also found within the suite. These volcanic rocks are surrounded by a ring dyke (?) of peralkaline granite.

Upper Aillik Group - The felsic members of the Upper Aillik Group are dominated by ignimbritic flows, rhyolitic breccias and quartz - feldspar porphyries. Reconnaissance samples include quartz - feldspar and quartz porphyries, very fine grained aphyric flows (?) and aegirine - feldspar foliated units.

Results of this summers work are difficult to evaluate as the quantity of rare metals in most rocks and in particular fine-grained volcanic rocks is difficult to anticipate without the required geochemical results. Work on the Letitia Lake and Strange Lake mineralization indicates that there is a positive correlation between radioactivity, as measured with a spectrometer, and rare metals in an outcrop or sample. This correlation has been applied to the samples collected from the 1991 target areas to give a qualitative idea of the amount of rare metals present; low potential is of no economic interest, medium potential needs further evaluation and high potential indicates values of economic interest. The following is a preliminary evaluation of the target areas:

Kings Point Complex - The peralkaline ignimbrites and related rocks sampled in the follow-up study confirm the medium potential for rare metals indicated in the 1990 field season results. Geochemical data are required to verify the potential indicated by the radioactivity measurements.

Topsails peralkaline granite - The samples in this granite indicate a low potential for rare-metal mineralization.

Sheffield Lake peralkaline volcanic rocks - Radioactivity measurements were not obtained for these rocks, thus geochemical data are required before an accurate evaluation can be made of them.

Little Pond Brook volcanic suite - The minor ignimbrites and flow breccias of this suite generally indicate a medium potential for rare metals; the felsic porphyries have a low potential.

Flowers River volcanic suite - Most of the massive and columnar jointed porphyries found in the lower part of the volcanic stratigraphy have low potential for rare metals. Aphyric and quartz-poor flows and fragmentals, found in the middle and upper portions of the stratigraphy, have a high potential for rare metals. Ignimbritic-textured rocks, also found in the middle and upper portions of the stratigraphy, have a high to very high potential for rare metals. Minor feldspar - quartz and quartz - mafic porphyries in the upper part of the stratigraphy have low to high radioactivity measurements and thus have some zones of medium to high potential.

Upper Aillik Group - Most of the reconnaissance samples collected from the Upper Aillik Group are from U showings, thus they all have very high radioactivity measurements. Geochemical analyses are needed to verify the correlation between radioactivity and rare metals observed in the Strange Lake and Letitia Lake mineralization.

Geochemical and other data are required to further evaluate these felsic rocks. Laboratory studies are on-going. Follow-up sampling and mapping of some of the more encouraging areas from the past two seasons sampling will be carried out next year.

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AN ALTERATION AND SULPHUR-ISOTOPE STUDY OF THE PILLEY'S ISLAND MASSIVE SULPHIDE DEPOSIT, CENTRAL NEWFOUNDLAND[3]

Frank Santaguida[1], Mark Hannington[2] and Craig Jowett[1]

The Roberts Arm - Buchans belt on Pilley's Island is host to several massive sulphide occurrences. Approximately 450,000 tons of pyritic ore was produced from the Old Pilley's Island Mine (estimated reserves of 1 M tonnes, 1.2 percent Cu), and a new sulphide zone has been located nearby (3B Zone). The deposits occur within a 200-m-thick, shallow-dipping sequence of altered dacite tuffs, volcanic breccias, and flows, which are well exposed at surface and in more than 24 km of drill core. The ore horizon is marked locally by a distinctive polylithic breccia. Regionally extensive mafic pillow lavas and breccias comprise the stratigraphic footwall. A zoned alteration envelope encloses the sulphide deposits and consists of stockwork-associated chlorite with widespread quartz-sericite K-feldspar. Several stages of chlorite are recognized and mineralization is most closely associated with an optically distinct, Fe-rich end member (up to 22 percent FeO). Application of a chlorite geothermometer indicates thermally intensifying hydrothermal activity from about 260°C, during early sericite-chlorite alteration, to about 350°C during peak alteration. Late-stage, Mg-rich chlorite appears to correlate with the collapse of the hydrothermal system and in influx of cold seawater. Mineralization at the Old Mine consists of massive to semi-massive pyrite and chalcopyrite with minor sphalerite: sulphur isotope ratios range from 2.3 to 6.5 per mil. Textures in the massive sulphides are characteristic of seafloor deposition, but disseminated and stringer sulphides (sub-seafloor replacement) also occur throughout. Transported sulphides, resembling ore from the Buchans Mine are exposed locally. One occurrence returns Zn grades up to 12 percent and sulphur isotope ratios from 1.1 to 1.8 per mil. This material is chemically and isotopically distinct from the Old Pilley's Island Mine and likely represents debris from the adjacent 3B Zone.

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[3] Contribution to the Canada - Newfoundland Cooperation Agreement on Mineral Development 1990-1994

VOLCANIC METALLOGENIC DATABASE COMPILATION

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This project was initiated in April, 1991, with the basic objective of compiling all available geochemical data on volcanic rocks for both the island of Newfoundland and Labrador. This will include all Department of Mines and Energy data as well as external data from theses and published sources. A software package (R-base 3.1) was chosen after consultation with the Geoscience Data Centre, and will be compatible with future in-house developments. The initial stages of the project involved familiarization with the software and with the concepts of database design.

Three fundamentally differing database structures were considered and one was selected. A small, test database was built using data that had previously been stored on hard disk. Data importation into R-base was facilitated by way of Lotus 123. Some data manipulation with a 123 macro was required to bring data into an appropriate format because the structure of the database does not conform to conventional geological data format. As a result, some ease of data manipulation has been sacrificed for ultimate ease of use and maximum flexibility of the database. For example, a user will be able to select data by sample number, rock type, unit, NTS, element or oxide, method of analysis, year of analysis, analytical laboratory, or level of element abundance. Where, as is often the case, more than one dataset exists for a particular sample, the combination of element, analytical method, laboratory and year of analysis will permit unambiguous identification of data, and priority can be assigned to certain analyses so that a user can easily select the best data available for any particular sample.

Standardized forms for manual input of data have been designed and will be used where data is not available in electronic format. Standardized reports for data output to printer or ASCII file have also been designed.

As of August of this year, the test database has been completed and tested, and "real data" input into the database has begun.

PROGRESS IN MARINE-PLACER SURVEYS OFF NORTHEAST NEWFOUNDLAND[1]

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Two seasons of fieldwork have now been completed off northeast Newfoundland, between White Bay and Cape Freels, as part of a program to determine the potential of the region to host marine placers, particularly gold placers. Using vessels based at the Atlantic Geoscience Centre, surveys have been completed using seismic-reflection systems and sidescan sonar. A total of 219 grab samples, 19 cores, and 119 bottom photographs have been collected. The surveys have yielded valuable new data on the extent and nature of the Quaternary sediments offshore in this region.

In 1990, two cruises were completed: 90-013 (C.S.S. Hudson) and 90-035 (C.S.S. Navicula). Geochemical analyses of samples from the Hudson survey showed anomalous gold levels in samples obtained offshore from the Baie Verte Peninsula, particularly within Baie Verte itself. Geochemical analyses and assays from cruise 90-035 confirm the occurrence of anomalous gold levels in Baie Verte and elsewhere (La Scie, Hamilton Sound, outer Halls Bay). The character and areal extent of the host deposits (postglacial sand and gravel) in Baie Verte have now been delineated.

In 1991, C.S.S. Dawson (cruise 91-026) was used for surveys at La Scie and Tilt Cove, in Bay of Exploits and Hamilton Sound, and offshore from the Straight Coast. Several vibracores were obtained in addition to large-volume IKU grab samples. On the subsequent Navicula cruise (91-031), the areas surveyed comprised Ming's Bight (near Baie Verte), Deer Cove (in Baie Verte), the west coast of White Bay as far north as Coney Head, and the Moreton's Harbour region. Samples from these surveys will be analyzed soon, and the results will be released in 1992.

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[1] Contribution to the Canada-Newfoundland Cooperation Agreement on Mineral Development, 1990-1994.

METALLOGENY OF BASE-METAL SULPHIDE OCCURRENCES IN THE LABRADOR TROUGH EAST OF SCHEFFERVILLE

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INTRODUCTION

Base-metal and pyritic sulphide showings are widespread in sedimentary rocks and gabbros in the Labrador Trough, east of Schefferville (Figure 1). Most of the showings on the Labrador side of the provincial boundary occur between Howse Lake in the north and Andre Lake in the south.

A reconnaissance investigation was made of a number of these showings to determine whether any variations in metallogeny could be recognized. Helicopter-supported traverses were made in the Galena Lake, Andre Lake, Martin Lake and Howse Lake areas to a number of showings, particularly those that had been highly rated by explorationists and/or those that seemed, from assessment reports, to be of special metallogenic significance.

REGIONAL GEOLOGY

Most of the showings investigated in the present study are in the Howse Zone of the Labrador Trough (Wardle *et al*., 1991). Stratigraphy in the Howse Zone encompasses a Lower Proterozoic sequence of basal continental arkose overlain by a thick, deep-marine clastic sediments (turbidites, graphitic shale) with minor carbonates and voluminous intercalated basalt flows and gabbro sills. The basalts are dominantly of oceanic tholeiite character and interpreted to be of rift origin (Wardle and Bailey, 1981; Findlay *et al*., 1990).

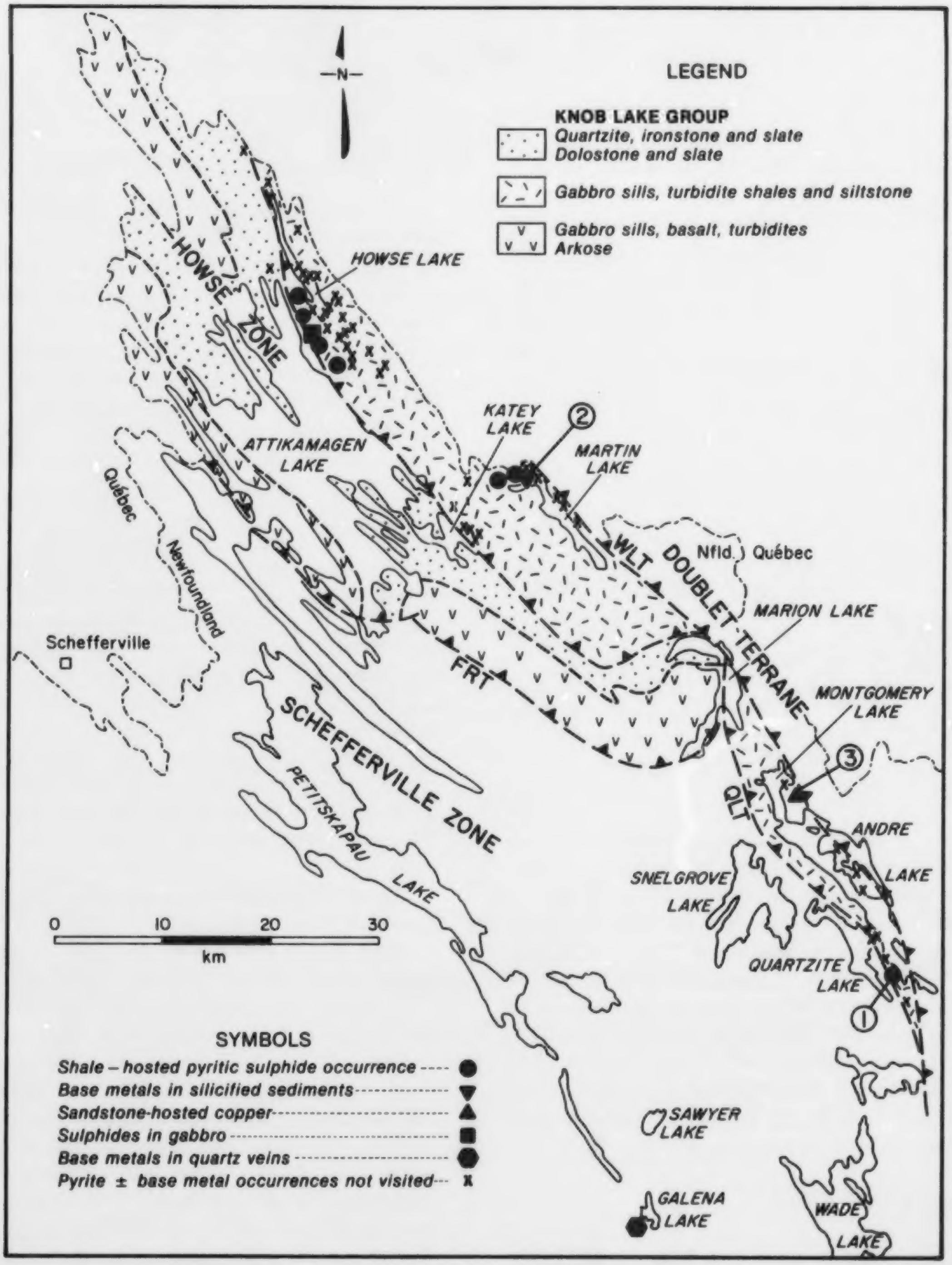
MINERALIZATION

There are more than 50 pyrite and base-metal showings in the Labrador portion of the Trough between Howse Lake and Andre Lake (Figure 1). Based on the preliminary observations of the 1991 field season, there seem to be at least five distinct types of mineral occurrence:

1) *Shale-hosted pyritic (cupriferous) sulphides*: This is the most widespread type of sulphide occurrence in the area. Several occurrences were examined in the area southwest of Howse Lake as well as the Jimmick Lake and Chicago Lake occurrences near Martin Lake, several occurrences near Katey Lake, and the Andre Lake # 1 occurrence. Mineralization typically comprises stratiform laminae and narrow beds of massive pyrite, pyrite concretions ranging from a few millimetres to several centimetres in diameter, disseminated pyrite, and pyrite veinlets in black, graphitic shales. The pyrite is locally accompanied by minor amounts of copper, and nickel has been reported in a few showings. To date, no major concentrations of base metals have been reported and none were seen during the present investigation. The mineralization is clearly syngenetic and individual mineralized shale units can be traced for a considerable distance (i.e., hundreds of metres) along strike. If any of these sulphidic shale units are found to contain base metals, there is a considerable size potential;

2) *Polymetallic base metals in silicified sediments*: This deposit type is typified by the Martin Lake #1 showing on the north shore of Martin Lake (Figure 1). Very coarse pyrite, chalcopyrite and sphalerite are closely associated with silicification. In contrast to the previously-described shale hosted occurrences, the Martin Lake #1 showing contains significant amounts of zinc and minor lead as well as copper. The metal contents and associated alteration render this occurrence distinct from other shale-hosted occurrences in the area. However, further study is required to determine whether it is a distinct deposit type or a variation of the shale-hosted type.

3) *Sandstone-hosted copper*: This deposit type is represented by the Montgomery Lake showing. Chalcopyrite is disseminated and forms


—N—
LEGEND
KNOB LAKE GROUP
Quartzite, ironstone and slate
Dolostone and slate
Gabbro sills, turbidite shales and siltstone
Gabbro sills, basalt, turbidites
Arkose
HOWSE ZONE
HOWSE LAKE
KATEY LAKE
②
MARTIN LAKE
ATTIKAMAGEN LAKE
Québec
Newfoundland
Nfld.
Québec
WLT
DOUBLET TERRANE
MARION LAKE
Schefferville
FRT
MONTGOMERY LAKE
③
SCHEFFERVILLE ZONE
PETITSKAPAU LAKE
QLT
ANDRE LAKE
SNELGROVE LAKE
QUARTZITE LAKE
①
0
10
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km
SYMBOLS
Shale – hosted pyritic sulphide occurrence ●
Base metals in silicified sediments ▼
Sandstone-hosted copper ▲
Sulphides in gabbro ■
Base metals in quartz veins ⬢
Pyrite ± base metal occurrences not visited x
SAWYER LAKE
GALENA LAKE
WADE LAKE

Figure 1. General geology (after Wardle *et al.*, 1991) and base-metal sulphide occurrences of the Labrador Trough east of Schefferville. Geological units in the Howse Zone patterned. FRT - Ferrum River thrust; QLT - Quartzite Lake thrust; WLT - Walsh Lake thrust. Mineral occurrences referred to in text are: 1 - Andre Lake No. 1; 2 - Martin Lake No. 1; 3 - Montgomery Lake.

patches in altered arkosic sandstone and pebbly conglomerate. The origin of the mineralization is unclear and requires further study;

4) *Sulphides in gabbro*: Only one example of this type of mineralization was noted in the present investigation although disseminated sulphides are reported to be widespread in gabbros in the Howse Lake area (Findlay *et al.*, 1990). The occurrence which was visited during the present study southwest of Howse Lake comprises narrow veinlets of pyrite and pyrrhotite(?) in a coarse grained gabbro near the contact with a pyritic shale unit.

5) *Base metals in quartz veins*: This deposit type is represented by the Galena Lake prospect in the Schefferville Zone. The showing consists of a series of anastomosing, northeast-trending quartz veins up to 1-m-wide hosted by mafic volcanic rocks and/or gabbros. The veins show clear evidence of multiple injection (sheeting, coxcomb textures) and locally carry patches of massive argentiferous galena and sphalerite. Although the vein system is clearly continuous over a considerable strike length (more than 600 m), the mineralization within it is patchy and overall grades in the exposed veins do not approach economic values.

CONCLUSIONS

The western part of the Labrador Trough exhibits a complex metallogeny. There appears to be potential for a number of economically-interesting base-metal deposit types and sufficient exposure to apply generally-accepted deposit models in grassroots area selection for attractive base-metal targets.

The widespread presence of syngenetic pyrite in graphitic shales, coupled with the local presence of copper in these showings and the abundant evidence for synchronous magmatism suggests a significant potential for shale-hosted massive sulphides. The magmatic association (i.e., abundance of basalts and approximately coeval mafic intrusions) coupled with the copper-rich metal association (rather than zinc, lead, and barite) suggests that deposit models for Besshi-type (Mitchell and Bell, 1973; Fox, 1984) rather classic sedimentary exhalative (SEDEX; e.g., Large, 1980; Goodfellow *et al.*, 1990) mineralization might be appropriate. Similarities between Besshi-type mineralization and large shale-hosted sulphide deposits in similar settings in adjacent Quebec have been pointed out by Fox (1984) and Barrett *et al.* (1988). Wardle and Bailey (1981) have previously suggested that the Gulf of California provides a good modern analogue for these rocks. Massive sulphide deposits presently forming in the Gulf of California are widely cited as examples of modern Besshi-type deposits (e.g. Fox, 1984; Slack and Shanks, 1990).

Most occurrences of this type documented to date are metal-poor. Future studies will attempt to identify areas where significant amounts of base metals were being delivered by the hydrothermal systems to the depositional environment. The presence of significant Zn and Pb in the Martin Lake showing may indicate that this is a good place to start, if this deposit is indeed related to the shale-hosted occurrences.

A potential for nickeliferous sulphide deposits in the gabbro sills of the Howse Lake area has been noted by many previous authors. Findlay *et al.* (1990) documented an immiscible sulphide phase in the gabbros, in which the sulphur was interpreted to be dominantly derived from the adjacent sedimentary rocks. However, values for base metals and PGE returned to date are generally low.

The potential for other types of base-metal deposits in this part of the Labrador Trough requires further study. A more precise documentation of the mineralization at Montgomery Lake may yield a rationale for regional targets for sandstone-hosted copper. Likewise, more detailed study of the Galena Lake occurrence is needed to determine whether other metals of value besides the silver-base metal association is present. Studies in future years will focus of the various deposit types in an effort to erect a model of regional metallogeny that can be used predictively to help focus exploration in favourable areas.

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REGIONAL GEOLOGY - LABRADOR

GEOLOGICAL MAPPING OF THE ARCHEAN ASHUANIPI COMPLEX, SUPERIOR PROVINCE, WESTERN LABRADOR

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PROJECT DESCRIPTION

In 1991, a systematic 1:100,000-scale mapping program of the Archean Ashuanipi Complex, forming the southeastern edge of the exposed Superior Province, was conducted in western Labrador. Mapping occurred in NTS map sheet 23G, including map sheets G/7, G/10, G/11, G/13, G/14 and G/15.

Prior to the 1991 field season, this area had only been covered by small-scale, reconnaissance mapping, hence the geology was not known in sufficient enough detail to meet current exploration needs. The purpose of the 1991 mapping program was to meet these needs by mapping the distribution of rock units and major structures. The results of this field program will provide a regional geological base for the gold-reconnaissance investigation of the Ashuanipi Complex carried out by the Newfoundland Department of Mines and Energy (see Thomas and Butler, 1987; McConnell *et al.*, 1987), and earlier, lake-sediment geochemistry programs carried out jointly with the Geological Survey of Canada (1982). Gold mineralization discovered in the Ashuanipi Complex, north of Schefferville, Quebec (see Lapointe, 1986) is associated with metamorphosed iron formation in high-grade supracrustal rocks, and there is the potential for similar rocks to occur in the map area. This study will also make a contribution to the overall understanding of structural, metamorphic and intrusive relations in this part of the Ashuanipi Complex.

The area mapped in 1991 is a southward continuation of the 1:125,000-scale mapping of the Ashuanipi Complex by Percival (1989) in the adjoining NTS map sheet, 23J.

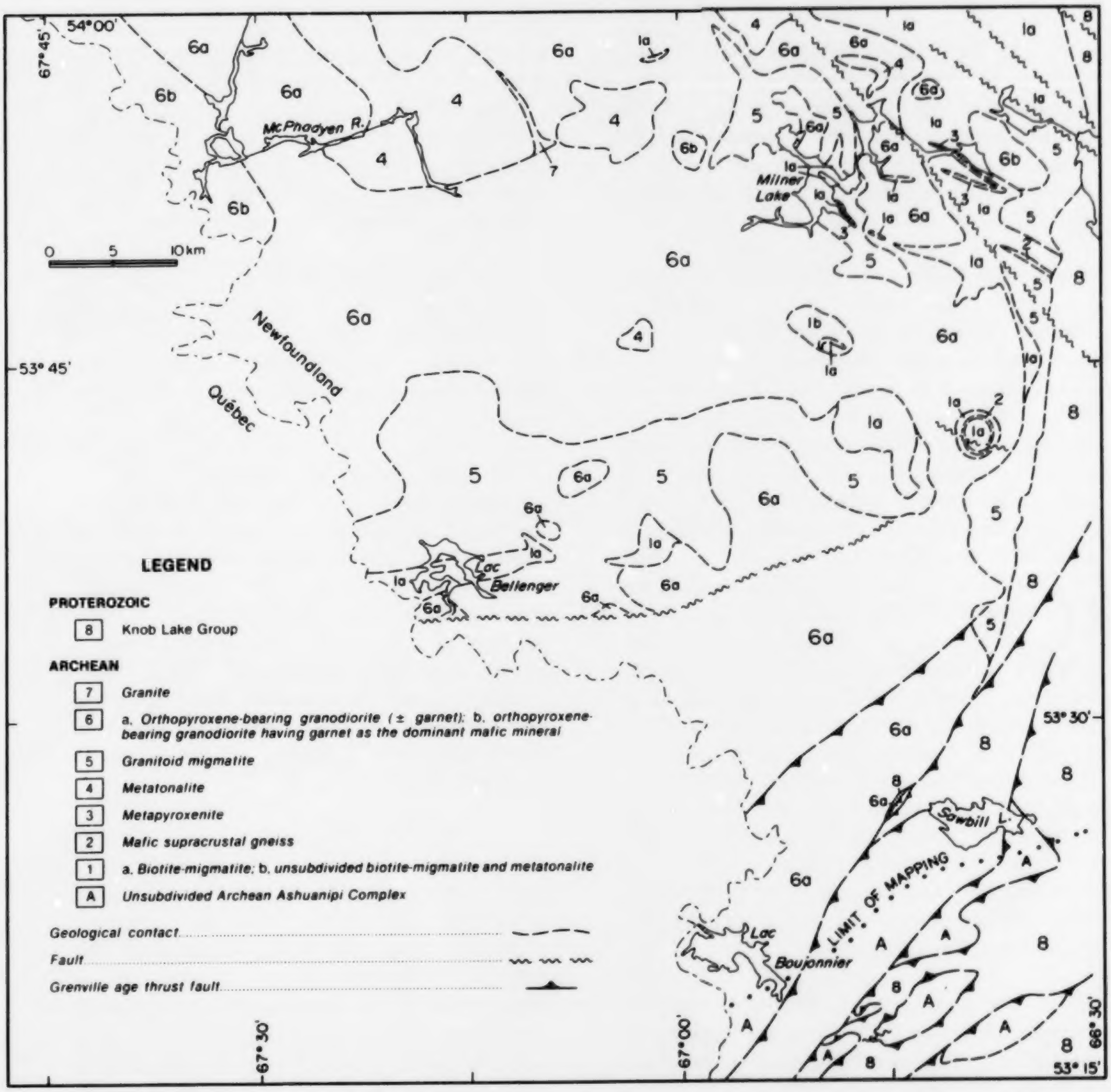
SUMMARY OF RESULTS

The map area (Figure 1) is composed of deformed granulite-facies rocks including metamorphosed supracrustal rocks, metatonalite, granitoid migmatite, orthopyroxene-bearing granodiorite, and minor unmetamorphosed but variably deformed granite intrusions. The supracrustal rocks are mainly biotite - migmatite, probably derived from pelite and greywacke, and minor mafic gneiss that may be derived from mafic volcanic rocks. Locally, the biotite-migmatitic unit has meta-pyroxenite dykes.

The metatonalite occurs in sheet-like bodies on all scales in the biotite - migmatite unit and as larger plutons within the map area. The rocks are varied in texture from a foliate having coarse-grained orthopyroxene to tonalite migmatite.

The granitoid migmatite unit is composed mainly of granodiorite and tonalite migmatite gneiss and a lesser amount of clinopyroxene-bearing granodiorite and tonalite foliate. These rocks represent metamorphosed igneous rocks that were intrusive to the supracrustal rocks. The unit also contains a minor amount of supracrustal rocks; these forming thin and discontinuous lenses. Sheets of unmetamorphosed but variably deformed leucogranite are common in the granitoid migmatite unit.

The most common rock type in the map area is an orthopyroxene-bearing granodiorite or orthopyroxene-diatexite. Garnet is a common constituent, and locally, is the most abundant mafic mineral present. Biotite is ubiquitous. The unit has a variable amount of inclusions of supracrustal rocks, metatonalite and granitoid migmatite; these being most abundant in areas adjacent to the contacts with the surrounding units. Locally, the amount of inclusions exceeds 60 percent of the unit. The unit is also highly varied in structure from massive to foliated to gneissic. Locally, the rocks have a pseudo-gneissosity defined by highly attenuated inclusions.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0 5 10km
McPhadyen R.
Milner Lake
Newfoundland
Québec
Lac Bellenger
Sawbill L.
Lac Boujonnier
LIMIT OF MAPPING
LEGEND
PROTEROZOIC
8 Knob Lake Group
ARCHEAN
7 Granite
6 a. Orthopyroxene-bearing granodiorite (± garnet); b. orthopyroxene-bearing granodiorite having garnet as the dominant mafic mineral
5 Granitoid migmatite
4 Metatonalite
3 Metapyroxenite
2 Mafic supracrustal gneiss
1 a. Biotite-migmatite; b. unsubdivided biotite-migmatite and metatonalite
A Unsubdivided Archean Ashuanipi Complex
Geological contact
Fault
Grenville age thrust fault

Figure 1. General geological map of the Ashuanipi Complex in part of NTS map sheet 23G, western Labrador. South of the area covered by the 1991 mapping program, the outline of the Ashuanipi Complex is a modified version from that shown by Rivers (1985).

All of the Archean rocks are deformed by at least two phases of folding that are manifest as outcrop- to map-scale dome and basin, or Type II, interference fold structures. These structures are defined by unit contacts, and the deformed principal foliation and gneissosity. The deformed planar structures are chiefly defined by granulite-facies assemblages but locally by amphibolite-facies minerals in areas of retrogressed granulite.

In the northern part of the map area, the eastern margin of the Ashuanipi Complex is presumed to be unconformably overlain by the Early Proterozoic Knob Lake Group. In contrast, the Archean - Proterozoic boundary in the southern part of the area is a thrust contact. Thrusts also cut the Archean - Proterozoic contact; these extend into the Ashuanipi Complex where they are marked by low-grade, steep-dipping ductile to brittle shear zones, and recognized geophysically as prominent, regionally persistent aeromagnetic breaks. The thrusting is Grenvillian in age.

The biotite - migmatite unit and the mafic gneiss unit have local occurrences of thin, generally less than 2 m, rusty-weathering sulphide zones. From examinations of hand specimens in the field, pyrite appears to be the sulphide mineral present. Samples were collected from several of the sulphide zones for analysis. Metamorphosed iron formation was not observed.

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NAIN AREA FIELD WORK, 1991

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Severe ice conditions on the northern Labrador coast hampered shoreline work on the archipelago east of Nain (Figure 1) until the first week of August. At that time, examination of the Archean gneiss complex on islands northeast and southeast of Nain began, completing work begun in 1990. In addition, five days were spent examining anorthositic rocks adjacent to a gneissic septum on the south shore of Nain Bay.

The Archean gneisses exposed on the islands northeast of Nain are predominantly granulite facies, brownish weathering, quartzofeldspathic rocks; mafic and metasedimentary supracrustal belts form only a minor component. Metamorphosed and deformed mafic dykes of several generations cut all rocks. On Bouverie Island, younger pink granite dykes form a northeast-trending swarm and stockwork cutting the gneisses and metamorphosed dykes. These granite dykes resemble, and are probably equivalent to, the Middle Proterozoic Manvers granite.

Granulite and retrogressed granulite-facies gneisses intruded by several generations of metamorphosed basic dykes also occur in the islands east of Nukasusutok Island. Here, mafic and metasedimentary gneisses are more abundant than in the northern area; the metasedimentary

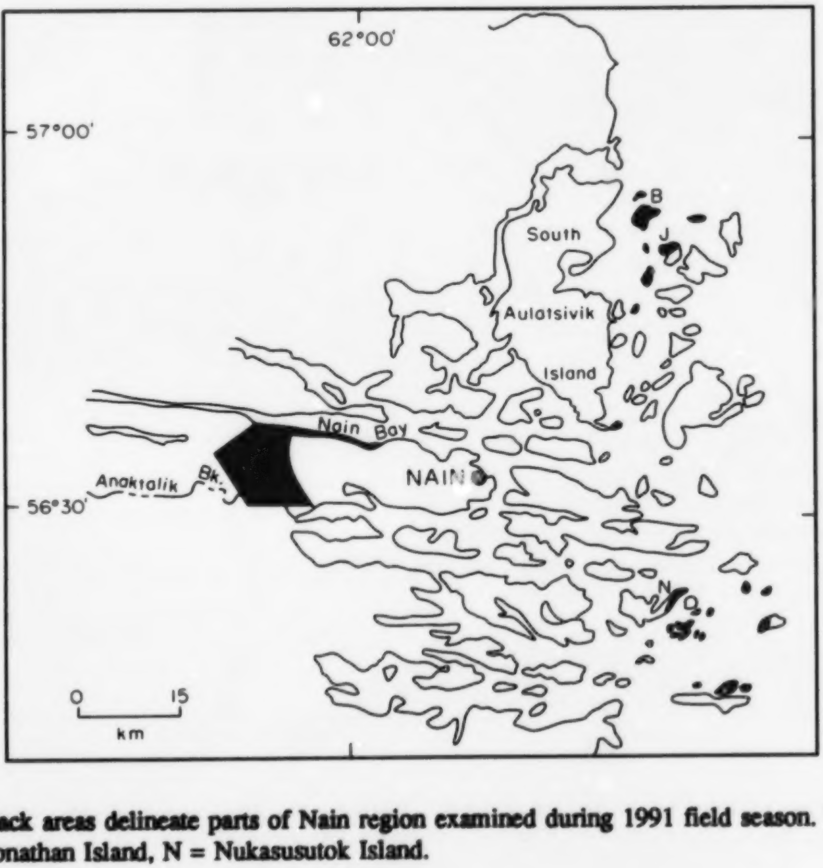

Figure 1. Black areas delineate parts of Nain region examined during 1991 field season. B = Bouverie Island, J = Jonathan Island, N = Nukasusutok Island.

rocks include significant amounts of white and grey metaquartzite. Ductile shear zones re-orient gneissic layering on several of the islands near Nukasusutok Island; these shear zones also re-orient some metabasic dykes in the gneisses, but are also avenues for later (syntectonic ?) dyke intrusion.

A narrow septum of gneiss occurs within the Nain Plutonic complex south of Nain Bay. A helicopter-supported survey in this area has defined three units - a granulite-facies migmatite, a garnetiferous diatexite, and a homogeneous foliated enderbitic gneiss. The granulite gneisses are bordered on the east by a foliated to gneissic anorthosite and norite; this anorthosite - norite is in turn intruded by a massive, coarse grained ilmenite-bearing leuconorite. To the west, the gneisses are bordered by white, foliated anorthosite and norite. Both the gneisses and anorthositic rocks are intruded by elongate stocks and dyke networks of olivine-bearing ferro-dioritic, monzonitic and quartz monzonitic rocks. These younger intrusions are also foliated and lineated.

A few sulphide-rich zones occur within the gneisses and anorthositic rocks. Coarse pyrite occurs in a narrow rusty zone in mafic gneisses on an island east of Nukususutok; ilmenite and pyrite occur within a foliated, layered metanorite on a small islet east of Nukususutok Island. Coarse-grained pyrite and ilmenite occur in a prominent rusty pegmatitic noritic dyke intruded into well-layered metanoritic rocks on the south shore of Nain Bay; similar smaller rusty zones occur in other dykes in the same area.

GEOLOGY OF THE ALEXIS RIVER MAP REGION, GRENVILLE PROVINCE, EASTERN LABRADOR

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During the 1991 field season, systematic 1:100,000-scale mapping was carried out in the Alexis River map region, which consists of NTS 1:50,000 sheets 13A/11, to 14. The region, which encompasses approximately 3700 km^2, lies within the Grenville Province of southeastern Labrador (Figure 1).

The region is subdivided into three geological zones based on contrasting lithological and structural signatures.

The northeastern half of the map area consists of several narrow (3 to 10 km wide) northwest-trending belts of variably (but generally intensely) deformed rocks, which include: biotite ± hornblende ± garnet granite - granodiorite gneiss; sillimanite + garnet-bearing, migmatitic pelitic and psammitic gneiss (and also includes minor occurrences of calc-silicate gneisses); hornblende-rich, locally migmatitic dioritic to amphibolitic gneiss; K-feldspar megacrystic biotite ± hornblende granodiorite - granite (varies from foliated to gneissic); strongly foliated, non-megacrystic, biotite ± hornblende granodiorite - granite; meta-anorthositic to metagabbronoritic rocks of the Alexis River Anorthosite and metagabbroic rocks associated with the White Bear Arm Complex (Gower *et al.*, 1987).

All units in this area are imparted with a northwest-trending fabric, which along with the trend of the belts, rotate towards a north-south orientation in the northwest corner of the area.

The southeastern arm of the map region is dominated by interfingering K-feldspar megacrystic granodiorite - granite and sillimanite-bearing pelitic and psammitic paragneiss. Large, lobate-shaped intrusions of variably deformed granodiorite - granite and diorite - quartz diorite are also present. Smaller bodies (enclaves or intrusions) of monzonite, metagabbro and orthogneiss are present as minor units. In contrast to the northeastern area, fabrics in this area are quite variable ranging from west to northeast trending.

The western area of the region is underlain almost entirely by an extensive lobate-shaped body consisting of syenite to quartz monzonite, associated with variable degrees of deformation. The body, as of yet, has not been subdivided on the map besides the distinction of a K-feldspar megacrystic phase and associated metagabbro.

Three main rock types are present: a moderately to strongly foliated biotite + hornblende monzonite; a K-feldspar megacrystic biotite + hornblende monzonite to quartz monzonite and a strongly foliated hornblende + biotite + pyroxene syenite to quartz monzonite. Fabrics within this unit vary from southwest to northeast.

Obvious post-Grenvillian rocks in the area include a gabbro - diabase dyke, interpreted as an extension of a late Precambrian northeast-trending dyke in the Paradise River map region to the north (Gower *et al.*, 1985), and small (20 to 60 cm wide) fine-grained diabase dykes, related to late Phanerozoic dykes mapped farther north (Gower *et al.*, 1987).

Mineral assemblages in the area suggest that mid-upper amphibolite-facies metamorphism was attained in all units, with exception of later dykes. Granulite-facies conditions are locally evidenced by the development of orthopyroxene-bearing assemblages. Noteworthy are small enclaves of apparently anhydrous metasedimentary gneiss within metagabbro in the extreme northeast corner of the area. These rocks are similar in appearance to sapphirine-bearing

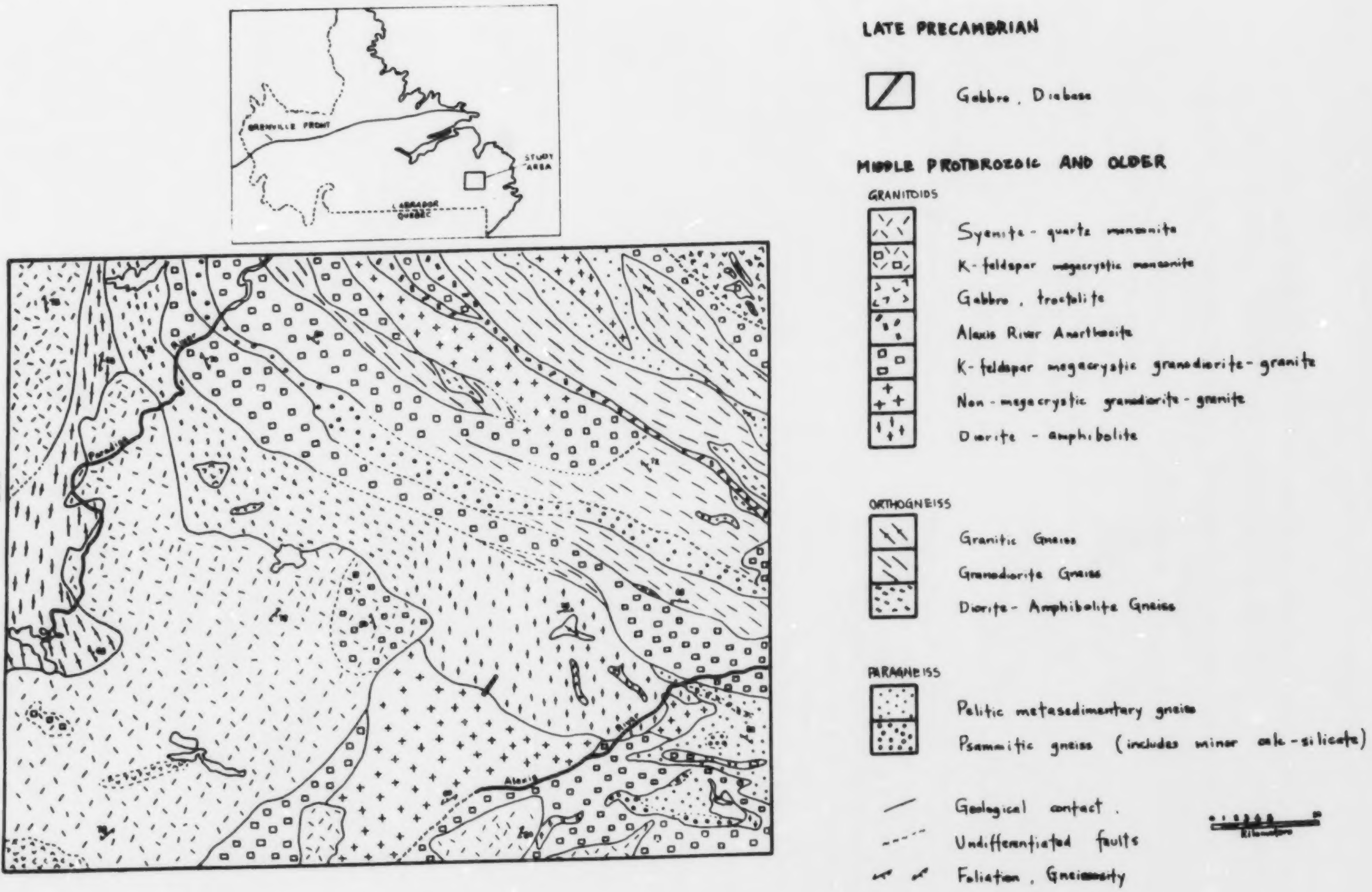
GRENVILLE FRONT
STUDY AREA
LABRADOR
QUEBEC
Paradise River
Alexis River
LATE PRECAMBRIAN
Gabbro , Diabase
MIDDLE PROTEROZOIC AND OLDER
GRANITOIDS
Syenite - quartz monzonite
K-feldspar megacrystic monzonite
Gabbro , troctolite
Alexis River Anorthosite
K-feldspar megacrystic granodiorite - granite
Non - megacrystic granodiorite - granite
Diorite - amphibolite
ORTHOGNEISS
Granitic Gneiss
Granodiorite Gneiss
Diorite - Amphibolite Gneiss
PARAGNEISS
Pelitic metasedimentary gneiss
Psammitic gneiss (includes minor calc - silicate)
Geological contact .
Undifferentiated faults
Foliation , Gneissosity
0 1 2 3 4 5 10
Kilometers

Figure 1. Geology of the study area.

gneisses described by Gower *et al.* (1986), in the Sandhill River area.

Economic potential in the area is limited to rusty weathering gossan zones, associated with metasedimentary gneiss; anomalous scintillometer readings (200 to 400 cps) of a few pegmatites and minor pyrite occurring in late northeast-trending faults.

REFERENCES

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1987: Geology of the Port Hope Simpson map region, Grenville Province, eastern Labrador. *In* Current Research. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 87-1, pages 183-199.

Gower, C.F., van Nostrand, T., McRoberts, G., Crisby, L. and Prevec, S.
1986: Geology of the Sand Hill River - Batteau map region, Grenville Province, eastern Labrador. *In* Current Research. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 86-1, pages 101-111.

Gower, C.F., Noel, N. and van Nostrand, T.
1985: Geology of the Paradise River region, Grenville Province, eastern Labrador. *In* Current Research, Part B. Geological Survey of Canada, Paper 85-1B, pages 547-560.

GEOLOGICAL MAPPING IN TORNGAT OROGEN, NORTHERNMOST LABRADOR

R.J. Wardle[1], Martin van Kranendonk[2], Flemming Mengel[3] and David Scott[4]

The Torngat project is a new program, undertaken jointly with the Geological Survey of Canada, designed to complete geological mapping of the northern tip of Labrador. The GSC part of the project is funded through the CNMDA but also includes an A-base component for mapping the area of Northwest Territories represented by Killinek Island. Field work for 1991 was entirely boat supported and restricted to the parts of the area accessible from the coast. This report covers mapping in the northern part of the area (NTS sheets 25 A/1, 2, 7 and 8); that to the south will be reported separately (Van Kranendonk, in prep.). Inland areas shown as unmapped on the accompanying map (Figure 1) will be completed in 1992 when extensive helicopter support becomes available.

Previous geological mapping was restricted to the regional 1:250,000-scale work of Taylor (1977). Reconnaissance investigations of mineral potential were carried out by Wilton and Wardle (1990).

The area lies within the part of the eastern Churchill Province referred to as the Torngat Orogen and is provisionally divided, on the basis of structure and rock type, into four zones (Figure 2). Zones 1, 2, 3 and 4 comprise Archean rocks that are correlative with those in the Nain Province to the south but which have been overprinted to varying degrees by Early Proterozoic deformation of *ca.* 1.8 Ga age. Zone 5 forms part of the so-called Burwell terrane (Wardle *et al.*, 1990), an enigmatic area that has been the subject of much speculation but about which until recently, relatively little was known.

Zone 1 comprises Archean, granulite-facies, migmatitic granitoid gneisses that occur interspersed with narrow belts of supracrustal gneiss and mafic granulite. These rocks have been intruded by a northeast-trending swarm of Lower Proterozoic metadiabase dykes that have been recrystallized during Lower Proterozoic metamorphism but which have escaped significant penetrative deformation.

Zone 2 is underlain by Archean gneisses similar to those of zone 1, but is dominated by belts of Lower Proterozoic ductile shearing and fabric straightening. These belts are associated with the reorientation of Archean gneissic fabrics and Lower Proterozoic dykes into north-south trends, and partial amphibolite-facies retrogression. Ductile shearing is thought to have been associated with a combination of oblique sinistral and later west-side-up reverse motion.

Zone 3 consists entirely of Archean anorthosite and related rocks. In previous mapping (Taylor, 1977) these rocks were depicted as a series of small lenticular intrusions but it is now recognized that they belong to a single pluton that extends well to the south of Figure 1 (Van Kranendonk and Scott, in prep.). The zone is believed to represent the deformed remains of a layered complex dominated by anorthosite and its gneissic equivalents, but also including layered metagabbro and minor amounts of ultramafic rock. Structural considerations suggest that the anorthosite has overthrust Zone 2 along steep west-dipping shears and may therefore represent a deeper level of the Archean crust than seen in zones to the east.

Stratiform sulphide zones (see below) have been discovered within the anorthosite. All rock types are cut by Lower Proterozoic, amphibolite-facies dykes.

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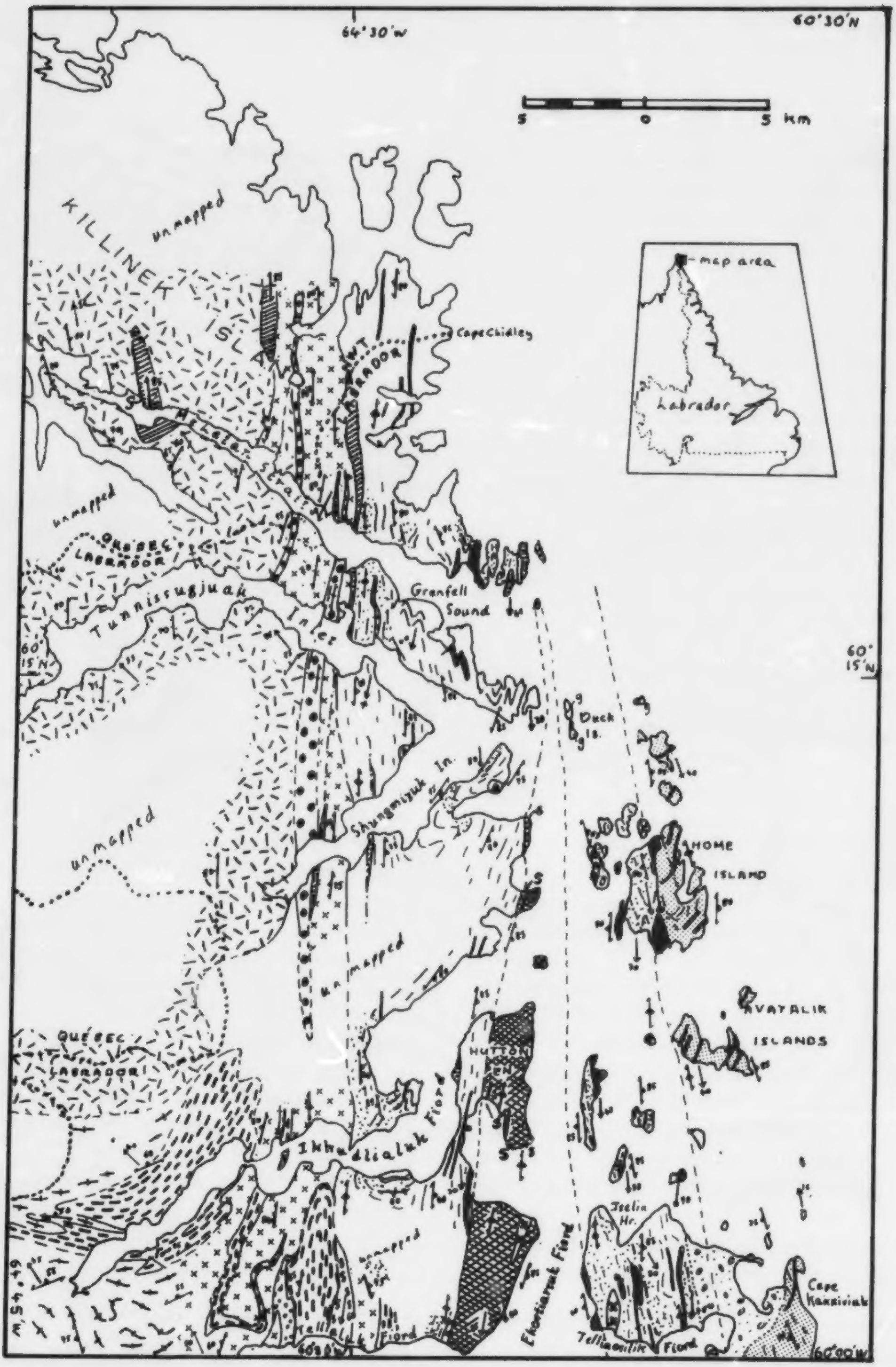
64°30'W
60°30'N
5 0 5 km
map area
Labrador
KILLINEK ISLAND
unmapped
Cape Chidley
N.W.T.
LABRADOR
McLelan Strait
unmapped
QUEBEC
LABRADOR
Tunnissugjuak Inlet
Grenfell Sound
60° 15'N
60° 15'N
Duck Is.
Shungmiuk In.
unmapped
HOME ISLAND
unmapped
NVATALIK ISLANDS
QUEBEC
LABRADOR
HUTTON PEN.
Ikkudlialuk Fiord
Ekortiarsuk Fiord
Iselin Hr.
Telliaosilik Fiord
Cape Kakkiviak
60°00'W

Figure 1. Geology of the area between Killinek Island and Ekortiarsuk Fiord.

LEGEND

⁘ **Fluvioglacial drift**

LOWER PROTEROZOIC

Meta-igneous rocks

● ● **Pink megacrystic granite:** *foliated to mylonitic*

⁙ **Buff charnockite:** *strongly foliated to gneissic*

× × **Grey diorite - quartz diorite - tonalite:** *moderately to strongly foliated and gneissic*

~ ~ **Grey to buff hypersthene-bearing tonalite gneiss**

Metasedimentary rocks

▨ **Rusty-weathering garnet-biotite pelitic and psammitic gneiss, ± sillimanite and graphite;** *generally strongly migmatitic. Contains minor interlayers of green quartzite and banded clinopyroxene-amphibolite (metavolcanic/volcaniclastic?)*

ʃ ʃ **Granitic migmatite,** *derived from metasedimentary gneiss*

⁖ **Grey banded, quartzofeldspathic psammitic gneiss,** *including minor mafic (volcaniclastic?) and pelitic bands*

▨ **Tasiuyak gneiss:** *interbanded white garnet-granite and rusty biotite-garnet-sillimanite-graphite pelitic gneiss*

// **Mafic dykes;** *varying from weakly deformed metadiabase dykes, containing sparse black plagioclase phenocrysts, in the east, to foliated metadiabase - amphibolite dykes, commonly porphyritic with white plagioclase, in the west*

LOWER PROTEROZOIC and/or ARCHEAN

x x **Grey diorite - metagabbro plutons,** *locally gneissic and migmatitic*

ARCHEAN

9 9 **Pink granite:** *moderately to strongly foliated*

▲ ▲ **Metagabbro:** *weakly to moderately deformed, locally migmatitic*

▩ **Anorthosite, anorthositic gabbro and anorthosite gneiss;** *minor layered amphibolite/metagabbro and ultramafic: strongly foliated to gneissic*

Granitoid gneisses: *migmatitic granitoid gneiss, commonly charged with abundant mafic and ultramafic inclusions and containing thin units of amphibolite and rusty supracrustal gneiss*

░ ***Buff granulite-facies gneisses***

⁙ **Grey to buff, granulite - amphibolite-facies (partially retrograded) gneisses;** *locally straightened and mylonitic*

⁙ **Grey amphibolite-facies gneisses** *containing abundant pink granite, granite gneiss and pegmatite; locally straightened and mylonitic*

Mafic - ultramafic and supracrustal gneisses

■ *Layered to massive amphibolite - mafic granulite, including rocks of probable plutonic and supracrustal origin; generally migmatitic*

■ **Meta-pyroxenite**

☰ **Rusty garnet, biotite, ± sillimanite and graphite pelitic to psammitic gneiss,** *interlayered with garnet-clinopyroxene-, ± hypersthene, amphibolite/mafic granulite gneiss*

SYMBOLS

∼	Geological contact	⤚	Foliation
- -	Inferred or extrapolated contact	→	Lineation
- -	Ultramylonite - mylonite shear zone	→	Minor fold plunge
⤚	Gneissic layering and foliation	S	Rusty sulphide zone

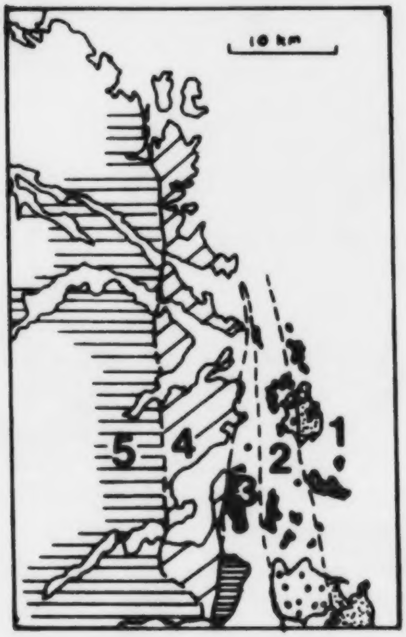

Figure 2. Major lithotectonic zones of the map area.

Zone 4 consists of more Archean gneisses similar to those encountered in zones 1 and 2. These rocks preserve widespread Archean granulite-facies assemblages but have been pervasively affected by Lower Proterozoic deformation and partially downgraded to amphibolite facies. In contrast to Zone 2 they have not been significantly affected by shearing and straightening. Amphibolite-facies Lower Proterozoic dykes are present but die out in the western part of the zone.

Zone 5 is composed predominantly of meta-plutonic rocks interspersed with belts of supracrustal gneiss, all of probable Early Proterozoic age. The meta-plutonic rocks form two principal associations; a massive charnockite pluton dominates the northwest part of the zone, whereas a complex association of diorite, quartz diorite, and tonalite, and their gneissic equivalents, predominates in the eastern and southern parts (Figure 1). The contact with Zone 4 has been locally established as intrusive, but is largely defined by narrow belts of ultramylonite and metasedimentary gneiss. These metasedimentary gneisses are identical to the Tasiuyak gneiss that occupies the suture of the Nain and Churchill provinces to the south and show a close spatial affinity with the charnockite. Other more extensive metasedimentary gneisses in the south of the area are different in appearance and contain thin banded amphibolites thought to represent meta-volcaniclastic units.

MINERALIZATION

Several pyritiferous gossan zones have been discovered within the Archean anorthosite of zone 3. These mineralized zones vary from centimetres to several metres in width and follow compositional layering in both anorthosite and layered metagabbro-ultramafic hosts. Strike length locally extends for several hundred metres, but in most cases has not been established. The sulphide zones are thought to have particular potential for PGE mineralization but as previously suggested (Wilton and Wardle, 1990), the anorthosite suite as a whole may also have potential for Ni and Cr mineralization. The greater-than-expected-extent of anorthosite, coupled with the recognition that it belongs to a single pluton, enhances this potential. Analyses are in progress for PGE, Ni and Cr, in addition to other trace elements.

Iron sulphide-rich gossans containing ≤ 60 percent visible sulphide were also found in supracrustal enclaves within Zone 5.

SUMMARY

This seasons work has established that:
1) Archean crust of Nain Province affinity extends well into northern Labrador and contains in its western part a large elongate pluton of anorthosite. Structural considerations suggest that the anorthosite may represent a deep level of the Archean crust.

2) the eastern Burwell terrane is a predominantly plutonic association originally intrusive into the Archean gneisses of the eastern part of the area. In this respect Burwell terrane may represent the roots of a magmatic arc developed upon, or accreted against, the western edge of the Nain craton.

3) The discovery of stratiform sulphide zones within the anorthosite enhances the mineral potential of the area and provides a new exploration target.

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1990: The eastern Churchill Province, Torngat and New Québec orogens: an overview. Geoscience Canada, Volume 17, pages 217-222.

Wilton, D. and Wardle, R.J.
1990: Geological Reconnaissance Survey of northernmost Labrador. Newfoundland Department of Mines and Energy, Geological Survey Branch, Report of Activities for 1990, pages 15-18.

GENERAL TOPICS

EARTH-RESOURCES DATA COMPUTER-BASED DIRECTORY

J. Butler
Geochemistry/Geophysics Section and Geoscience Data Centre

In 1990, the first edition of the Earth-Resources Data Computer-Based Directory was released. This directory contained a list of Quaternary, geochemical, lithogeochemical, geophysical and resource-based data files. The Quaternary, geochemical, and lithogeochemical files contain field observations and analytical data for a large number of elements collected in both reconnaissance and detailed surveys, from selected areas in Newfoundland and Labrador. The geophysical files generally cover the island of Newfoundland and contain field observation data, i.e., gravity, magnetic, gamma-ray and aeromagnetic. The resources-based files cover Newfoundland and Labrador and include the MODS database, the Mineral-Claims indices, the drill-core storage and retrieval information, the census and statistics for the operating mines, and both geochronological databases.

Several of the these databases have been compiled and are publicly available. These include the lake-sediment data for all of Newfoundland; the lake-sediment data for all of Labrador; granite data for all of Newfoundland; stream-sediment data files for both Newfoundland and Labrador; Quaternary data files for specific areas in Newfoundland and Labrador, and include some granite files for Labrador. A few files, of detailed lake- and stream-sediment data, are also available for Labrador.

An update of this data directory (Version 1.1) is currently being prepared for distribution and should be available during the Annual Review of Activities. A number of new databases have been added to this directory and several previous databases have been revised. This directory contains information on databases currently in use by the Geological Survey Branch and the Mineral Resources Management Branch of the Newfoundland Department of Mines and Energy. Each database is described in detail, and include information such as a list of variables in the database, size, format, availability, and contact person.

Inquiries about any of these databases should be made to the contact person listed with the database, the Database Manager, or to the Publication and Information Section of the Department of Mines and Energy.

NEWFOUNDLAND COMPUTERIZES ITS CLAIMS RECORDING OFFICE

Noel Gover
Mineral Rights, Mineral Lands Division

INTRODUCTION

Management of Newfoundland's Ground Staked Exploration Licences has entered the "Computer Age". In March of 1991, the final phase of the development and implementation of a computerized Mineral Rights Ground Staked Licencing System was completed. This computerized claims recording and licence management system was developed by Newfoundland and Labrador Computer Services Limited from specifications prepared by Newfoundland's Mineral Rights Recorder, Noel Gover.

SYSTEM GENERAL

The Mineral Rights System is a networked application allowing simultaneous use by several users. As installed, the Mineral Rights System runs on a Novell ELS Level II Network. It is a microcomputer system using a Dell 310 PC as a file server, and four other Dell PC's as work stations. The file server has a 90 Mb hard drive with 4 Mb of RAM and is used in the non-dedicated mode. All of the work stations have hard drives ranging from 20 to 40 Mb, consequently, they may be used as stand alone units.

SYSTEM STRUCTURE

Since the Mineral Rights system is relatively large, with respect to the software image size and the number of database and index files accessed, the system is partitioned into three smaller subsystems as follows:

A. Main Subsystem
B. Licencing Subsystem
C. Report Production Subsystem

Also, the Backup, Restore and Archive utilities are separated out and are performed using SYTOS batch files. The SYTOS software itself is used in conjunction with the TLC LEGACY tape backup unit to perform these functions. Since the SYTOS software is relatively large (over 140K) it could not be incorporated into one of the three Mineral Rights subsystems.

To link all of the above subsystems and utilities together the Novell menu system is used with a Mineral Rights system template. As a bonus, a Novell Utilities sub-menu has also been included whereby the user can perform such functions as monitoring the LAN print queues, obtain a LAN logon list, send messages to other users logged on to the LAN, and execute DOS commands. For more information on the Novell Utilities the user can consult the relevant Novell documentation.

Figure 1 represents a schematic of the system.

SOFTWARE

The program is written in dBase III (Ashton-Tate) and compiled with the Clipper Compiler (Nantucket). Having the program compiled allows it to be used independent of the dBase software.

PURPOSE

The system provides fast and efficient storage, retrieval and management of the Ground Staked Licence records. Exploration statistics and various reports are produced in order to chart the trends in mineral exploration industry to enable better resource management.

In addition, manual preparation of time consuming correspondence has been eliminated. Preparation of licences and covering letters, acknowledgement of receipt of applications, cancellation notices for the licence holder, and display notices has been automated.

SYSTEM OPERATING HIGHLIGHTS

In Newfoundland, a ground staked mineral licence is comprised of any number of

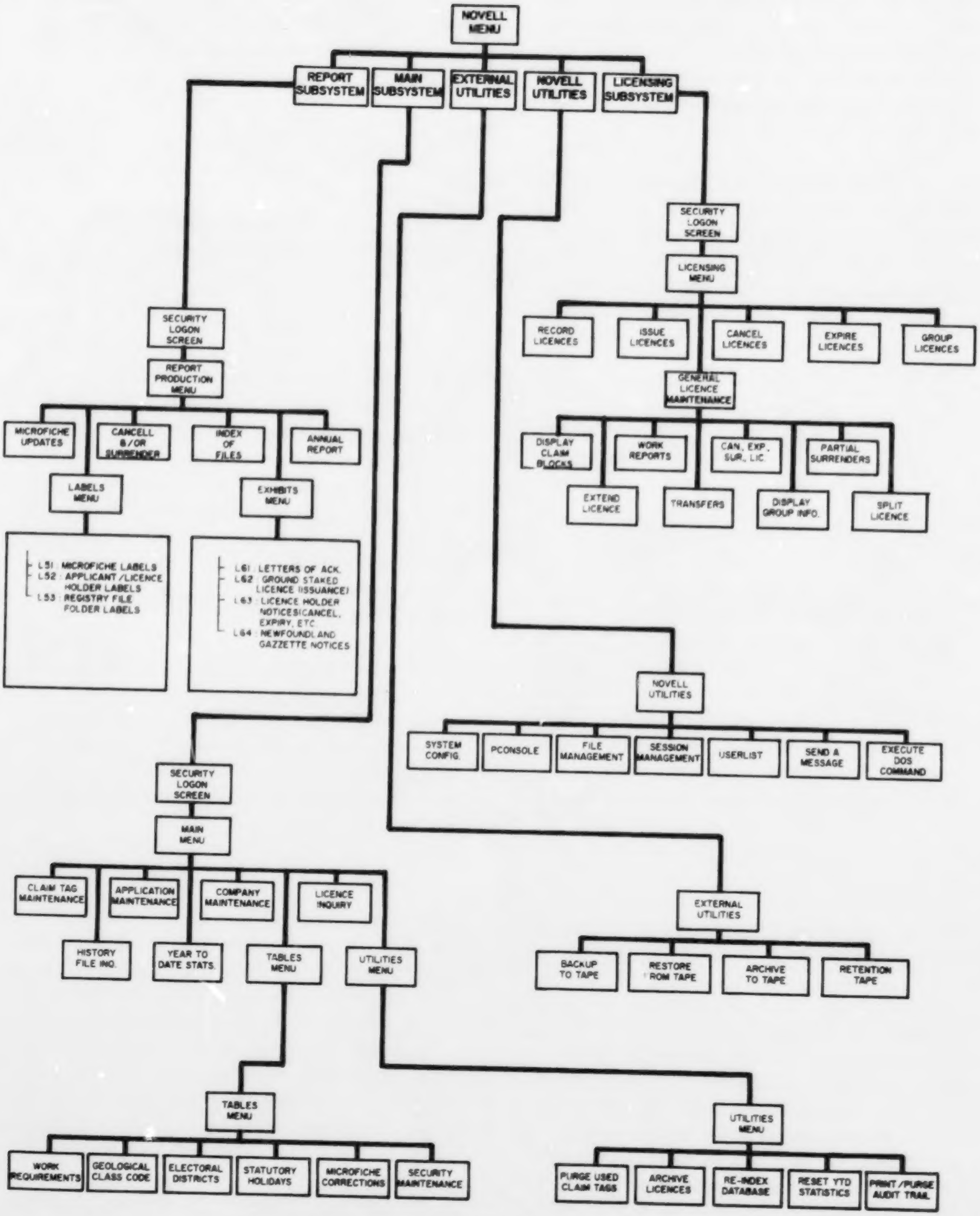
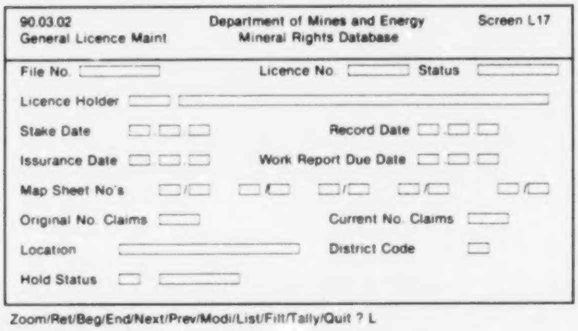
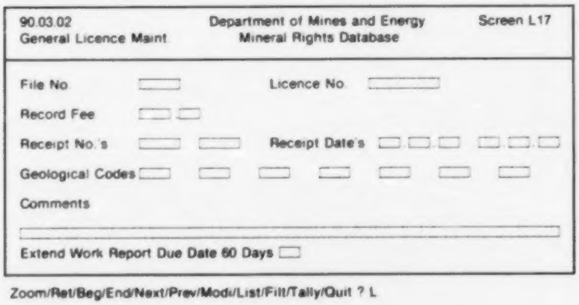

NOVELL MENU
REPORT SUBSYSTEM
MAIN SUBSYSTEM
EXTERNAL UTILITIES
NOVELL UTILITIES
LICENSING SUBSYSTEM
SECURITY LOGON SCREEN
LICENSING MENU
RECORD LICENCES
ISSUE LICENCES
CANCEL LICENCES
EXPIRE LICENCES
GROUP LICENCES
GENERAL LICENCE MAINTENANCE
DISPLAY CLAIM BLOCKS
WORK REPORTS
CAN., EXP., SUR., LIC.
PARTIAL SURRENDERS
EXTEND LICENCE
TRANSFERS
DISPLAY GROUP INFO.
SPLIT LICENCE
SECURITY LOGON SCREEN
REPORT PRODUCTION MENU
MICROFICHE UPDATES
CANCELL B/OR SURRENDER
INDEX OF FILES
ANNUAL REPORT
LABELS MENU
EXHIBITS MENU
L51 : MICROFICHE LABELS
L52 : APPLICANT /LICENCE HOLDER LABELS
L53 : REGISTRY FILE FOLDER LABELS
L61 : LETTERS OF ACK.
L62 : GROUND STAKED LICENCE (ISSUANCE)
L63 : LICENCE HOLDER NOTICES(CANCEL, EXPIRY, ETC
L64 : NEWFOUNDLAND GAZZETTE NOTICES
NOVELL UTILITIES
SYSTEM CONFIG.
PCONSOLE
FILE MANAGEMENT
SESSION MANAGEMENT
USERLIST
SEND A MESSAGE
EXECUTE DOS COMMAND
SECURITY LOGON SCREEN
MAIN MENU
CLAIM TAG MAINTENANCE
APPLICATION MAINTENANCE
COMPANY MAINTENANCE
LICENCE INQUIRY
HISTORY FILE INQ.
YEAR TO DATE STATS.
TABLES MENU
UTILITIES MENU
EXTERNAL UTILITIES
BACKUP TO TAPE
RESTORE FROM TAPE
ARCHIVE TO TAPE
RETENTION TAPE
TABLES MENU
WORK REQUIREMENTS
GEOLOGICAL CLASS CODE
ELECTORAL DISTRICTS
STATUTORY HOLIDAYS
MICROFICHE CORRECTIONS
SECURITY MAINTENANCE
UTILITIES MENU
PURGE USED CLAIM TAGS
ARCHIVE LICENCES
RE-INDEX DATABASE
RESET YTD STATISTICS
PRINT /PURGE AUDIT TRAIL

Figure 1. Schematic of the Mineral Rights System.

claims and claim blocks. A claim is a 400 metre square and a claim block is any number of claims staked in a square or rectangular group, up to and including 64. A prerequisite to staking is the purchase and use of claim tags. The system maintains a list of claim tags which have been sold and the tag status - active, used or returned.

Upon receipt of an application for a licence, all relevant information to create a licence record is entered into the system, such as; name, location and staking particulars. The system will assign a correspondence file number, a licence number, the recording date, the issuance date and the work report due date (Screen L17).


90.03.02 Department of Mines and Energy Screen L17
General Licence Maint Mineral Rights Database
File No. Licence No. Status
Licence Holder
Stake Date Record Date
Issurance Date Work Report Due Date
Map Sheet No's
Original No. Claims Current No. Claims
Location District Code
Hold Status
Zoom/Ret/Beg/End/Next/Prev/Modi/List/Filt/Tally/Quit ? L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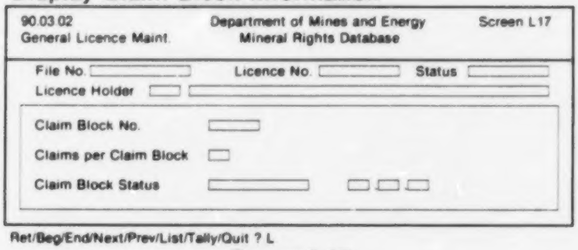
General Licence Maint Mineral Rights Database
File No. Licence No.
Record Fee
Receipt No.'s Receipt Date's
Geological Codes
Comments
Extend Work Report Due Date 60 Days
Zoom/Ret/Beg/End/Next/Prev/Modi/List/Filt/Tally/Quit ? L

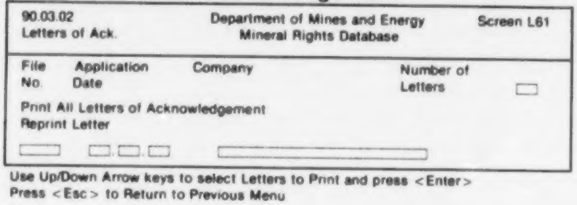
Display Claim Block Information


90.03.02 Department of Mines and Energy Screen L17
General Licence Maint. Mineral Rights Database
File No. Licence No. Status
Licence Holder
Claim Block No.
Claims per Claim Block
Claim Block Status
Ret/Beg/End/Next/Prev/List/Tally/Quit ? L

Screen L17

A file of statutory holidays is maintained to ensure that the assigned dates are working days only. In addition, a letter of acknowledgement for the applicant, a mailing label and central registry correspondence file folder label is generated and printed (Screen L61).

Print Letters of Acknowledgement

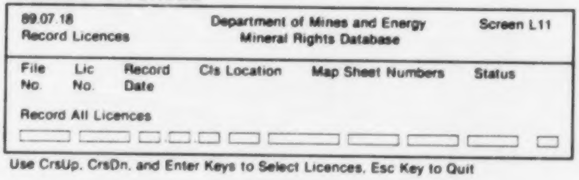

90.03.02 Department of Mines and Energy Screen L61
Letters of Ack. Mineral Rights Database
File No. Application Date Company Number of Letters
Print All Letters of Acknowledgement
Reprint Letter
Use Up/Down Arrow keys to select Letters to Print and press <Enter>
Press <Esc> to Return to Previous Menu

Screen L61

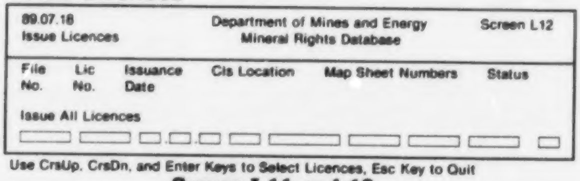
In order to avoid typographical errors in the licence holder name and for convenience of entering, all names are maintained in a company file. Therefore, whenever it is necessary to enter a name, such as for new applications, issuance of new claim tags or transfer of licences, the name is available from the company file by accessing it via a pop up menu and automatically assigning it to the record.

The regulations require that applications shall not be accepted (recorded) until after the expiry of 30 days from the date of staking. Also, licences cannot be issued until after the expiry of 30 days from the date of acceptance. Therefore, the system is prompted daily for recording and issuing dates (Screen L11 and 12).

Record Licences


89.07.18 Department of Mines and Energy Screen L11
Record Licences Mineral Rights Database
File No. Lic No. Record Date Cls Location Map Sheet Numbers Status
Record All Licences
Use CrsUp, CrsDn, and Enter Keys to Select Licences. Esc Key to Quit

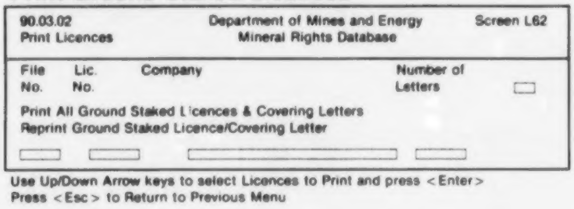
Issue Licences


89.07.18 Department of Mines and Energy Screen L12
Issue Licences Mineral Rights Database
File No. Lic No. Issuance Date Cls Location Map Sheet Numbers Status
Issue All Licences
Use CrsUp, CrsDn, and Enter Keys to Select Licences, Esc Key to Quit

Screen L11 and 12

Licences are recorded and issued by a simple stroke of the "ENTER" key. The licence itself is computer generated, and printed together with a covering letter for the licence holder (Screen L62).

Print Ground Staked Licences



90.03.02
Print Licences
Department of Mines and Energy
Mineral Rights Database
Screen L62

File No. Lic. No. Company Number of Letters

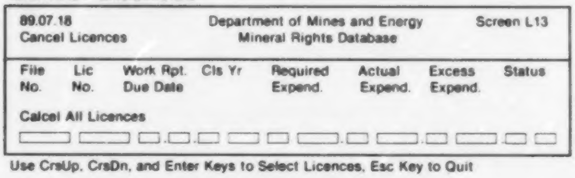
Print All Ground Staked Licences & Covering Letters
Reprint Ground Staked Licence/Covering Letter

Use Up/Down Arrow keys to select Licences to Print and press <Enter>
Press <Esc> to Return to Previous Menu

Screen L62

In a similar way, work report due dates are checked and licences which are deficient in assessment work credit may be cancelled automatically (Screen L13).

Cancel Licences



89.07.18
Cancel Licences
Department of Mines and Energy
Mineral Rights Database
Screen L13

File No. Lic No. Work Rpt. Due Date Cls Yr Required Expend. Actual Expend. Excess Expend. Status

Calcel All Licences

Use CrsUp, CrsDn, and Enter Keys to Select Licences, Esc Key to Quit

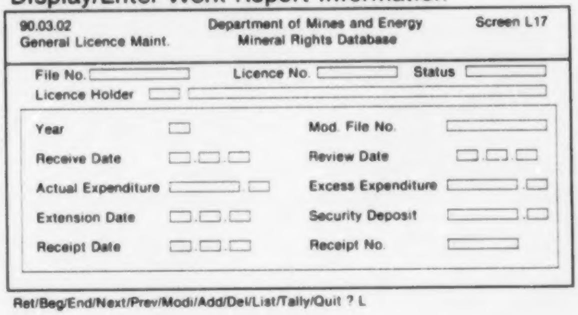
Screen L13

Licences with sufficient excess assessment work credit for the next year are highlighted so that the excess credit may be carried forward. Also, the work report due date is automatically moved up a year.

When licences are cancelled, a notice for the licence holder informing him of the cancellation and the reason for the cancellation is generated and printed. An appropriate display notice declaring the lands covered by the cancelled licence to be open for staking at a fixed date is also produced. Similarly, expiry dates are checked and licences which have expired are noted and the appropriate correspondence is printed.

Yearly assessment work calculations are automatic. For example, as assessment work reports are accepted, it is a simple matter to retrieve the licence or licences covered by the report and enter the date which the report received, reviewed and the value of the assessment work expended. The required value of the work for the year covered by the report, and any excess work credit is computed by the system and the record is updated. Yearly work requirements per claim is stored by the system to facilitate this computation (Screen L17).

Display/Enter Work Report Information



90.03.02
General Licence Maint.
Department of Mines and Energy
Mineral Rights Database
Screen L17

File No. Licence No. Status
Licence Holder

Year
Mod. File No.
Receive Date
Review Date
Actual Expenditure
Excess Expenditure
Extension Date
Security Deposit
Receipt Date
Receipt No.

Ret/Beg/End/Next/Prev/Modi/Add/Del/List/Tally/Quit ? L

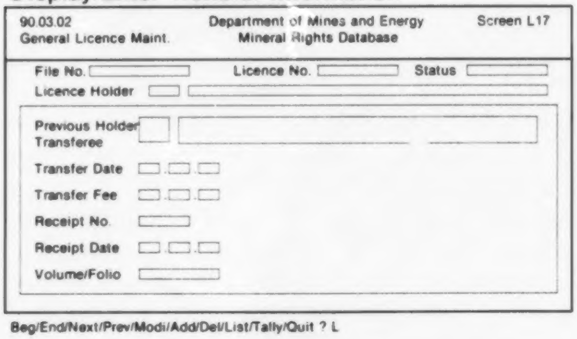
Screen L17

Newfoundland regulations allow for the grouping of two or more coterminous licences, provided all of the licences to be grouped have passed their first anniversary date and are in good standing. To group two or more licences, it is only necessary to enter the date of the grouping and the licence numbers to be grouped. The computer produces a number for the new grouped licence. A complete new grouped licence record is generated which includes the number of claims and any excess work credits calculated from the grouped licences. In addition, the new licence and a covering letter for the licence holder is automatically printed.

A licence holder may surrender a part of any licence at any time by submitting a notice of surrender. Complete claim blocks may be surrendered or portions of claim blocks may be surrendered by restaking the area(s) to be kept. Areas to be retained may be coterminous or consist of one or more separate areas. In the latter case, new reduced licences are issued. All combinations of partial surrenders are easily handled by the system. We need only highlight the claim blocks being surrendered, add the new claim blocks and assign any new licences with the appropriate blocks. In a similar manner to grouping, complete new records are generated by the system, with new reduced licences and covering letters being printed. Also, display notices for the blocks being surrendered are printed.

The system will allow records to be noted when licences have been transferred. We simply retrieve the licence, zoom to the transfer screen and add; the transferee, transfer date, transfer fee, receipt number and date, and the volume and folio numbers which indicate the filing location of the transfer document (Screen L17).

Display/Enter Transfer Information



90.03.02 General Licence Maint.
Department of Mines and Energy Mineral Rights Database
Screen L17

File No. ☐ Licence No. ☐ Status ☐
Licence Holder ☐ ☐

Previous Holder / Transferee ☐ ☐
Transfer Date ☐.☐.☐
Transfer Fee ☐.☐.☐
Receipt No. ☐
Receipt Date ☐.☐.☐
Volume/Folio ☐

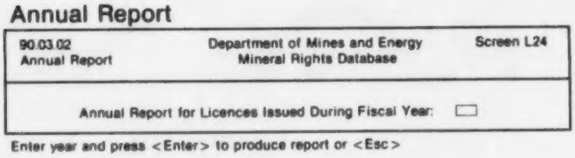
Beg/End/Next/Prev/Modi/Add/Del/List/Tally/Quit ? L

Screen L17

The retrieval of licence records is as easy as entering a licence number or a claim block number. A complete record relating to the licence (block) is available for viewing or printing. See Figure 2 for a sample printout.

Report production is an integral part of the system. Several standard reports are generated and printed when needed. The three main ones being; a monthly microfiche update report, this report consists of a record of all changes and additions to the database for every month. A quarterly cancellation/surrenders/expiry report which contains a listing of all licences surrendered, cancelled, partially surrendered and expired for any given quarter, and an annual report, containing a listing of all licences issued for a given year (Screen L21 and L24).

Annual Report

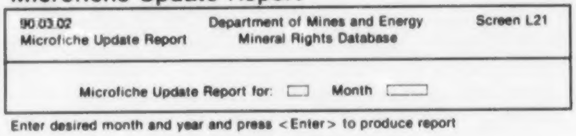


90.03.02 Annual Report
Department of Mines and Energy Mineral Rights Database
Screen L24

Annual Report for Licences Issued During Fiscal Year: ☐

Enter year and press <Enter> to produce report or <Esc>

Microfiche Update Report



90.03.02 Microfiche Update Report
Department of Mines and Energy Mineral Rights Database
Screen L21

Microfiche Update Report for: ☐ Month ☐

Enter desired month and year and press <Enter> to produce report

Screen L21 and 24

It is possible to sort through the main database and filter out selected data. For example, we can list all licences held by a particular company, all licences issued during a given period, all licences contained within a particular map sheet, all licences at a given location, and combinations. For example, all licences issued to company "X" during period "Y" for a given map sheet.

Current year to date statistics respecting number of claims staked, number of claims cancelled/ surrendered/expired, and total number of claims in good standing are available. The statistics are also available for any year back to 1980.

A backup and restore utility is provided in order to facilitate system security. The system is backed up daily using a three tape rotation, and a monthly backup using one tape. Security of the system is further enhanced by providing each user with a logon id and a password for both the Network and the Mineral Rights Database.

SUMMARY

The highly competitive and fast moving nature of the mineral exploration industry dictates that any recording office be able to respond to the industries needs in an efficient and timely manner. Our computerized system allows us to process claim information and compile statistics faster, thereby allowing us to respond promptly to the queries of the industry.

```
91.04.23                DEPARTMENT OF MINES & ENERGY
                              MINERAL RIGHTS
                             LICENCE INQUIRY

Licence Number:   3577
File Number:      771:2028
Original Holder:  Ionex Limited
Current Holder:   Cominco Ltd.
Address:          2200-120 Adelaide St. West
                  Toronto, ON
                  M5H 1T1
Licence Status:   Issued
Location:         Lake Ambrose,Central Nfld
Electoral Dist.:  14 Windsor-Buchans
Staked Date:      88.12.08
Recorded Date:    89.01.09
Issuance Date:    89.02.09
Work Due Date:    92.04.09
Org. No. Claims:  113
Cur. No. Claims:  113
Recording Fee:    565.00
Receipt(s):       10305 (89.01.09)
Map Sheet No(s):   12A/10
Geo. Class(es):

Comments:
Refund $20.00  First year expend. are prel.

Claim Blocks:

15985  48                   15986  50                    15987  15


Work Reports:
Yr  Receive    Review        Actual           Excess
    Date       Date          Expenditure      Expenditure
 1  90.03.02   90.05.31        32,356.23         9,756.23
 2  91.02.20   91.02.20        39,844.93        21,351.16

Licence Transfers:
                                      Transfer  Fee    Receipt Receipt  Volume/
                                      Date             Number  Date     Folio
Cominco Ltd.                          89.01.05  10.00  10305     .  .   7,41

Partial Surrenders: None

This Licence replaces Licence Number(s): None

This Licence is replaced by Licence Number(s): None
```

Figure 2. An example of a sample printout.

Also, this tool allows the department to perform its task of administering Newfoundland's mineral regulations fairly and effectively.

CONTACTS

Further information is available from:

Noel F. Gover, Mineral Claims Recorder
Telephone: 709-729-2773
Fax: 709-729-6782

Mineral Lands Division
Department of Mines and Energy
P.O. Box 8700
St. John's, Newfoundland
A1B 4J6

CORE-STORAGE PROGRAM, 1991

A. Harris and S. Cochrane
Mineral Lands Division
Mineral Resource Management Branch

INTRODUCTION

In 1979, the Newfoundland Department of Mines started a drill-core collection and storage program. The objective of this ongoing program is to provide well maintained and representative collections of drill core from as many drilling programs as possible, for the future use of the mineral exploration industry, government, and university geoscientists and other geotechnical professionals.

This report summarizes activities during 1991 and presents an overview of the operations of the core-storage program.

DRILL-CORE ACQUISITION

During 1991, drill-core acquisition continued in insular Newfoundland. The core-storage program acquired 24,164 m of core samples during this past year, from the following areas (Table 1).

Table 1. Total length of cores collected during 1991

Property	Company/Year	No. Holes	Meters
Betts Cove	(Inco) 1988-90	35	4,860
Baie Verte	(Corona) 1988-90	97	11,224
Bobby's Pond	(Inco) 1991	2	1,237
Avalon Peninsula	(Inco) 1990	2	346
Hickey's Pond	(Corona) 1990	4	420
Burlington Road	(Terra Gold) 1989	2	275
Jackson's Arm	(Carrick Resources) 1990	17	1,336
Cape Ray	(Dolphin Exploration) 1989	29	3,616
Goose Arm	(Len Pye) 1990-91	4	122
Wellsdale Fee Simple	(Wellsdale Gold Ms) 1979	18	728

In total, approximately 715,891 m of drill-core samples are now being stored.

A catalogue of all open-core samples in the Departmental core libraries is available from the Publications and Information Section of the Department of Mines and Energy.

DRILL-CORE LIBRARIES

The Department of Mines and Energy now operates six core libraries located at St. John's, Buchans, Springdale, Baie Verte, Pasadena and Goose Bay (Figure 1).

The St. John's library is staffed on a full-time basis except during the field season. It is equipped with a rock saw, a stereomicroscope, a magnetic susceptibility meter, a resistivity meter, an ultraviolet light and a McPhar TV-1 scintillometer.

The Goose Bay core library, which contains core material from Labrador, is not staffed on a full-time basis. It has facilities similar to, and shares equipment with, the St. John's core library.

The Pasadena core library is staffed on a full-time basis. This library has equipment similar to the St. John's library along with a ventilated room for storing radioactive core and a humidity-controlled room for storing salt cores. The Pasadena building is filled to capacity and

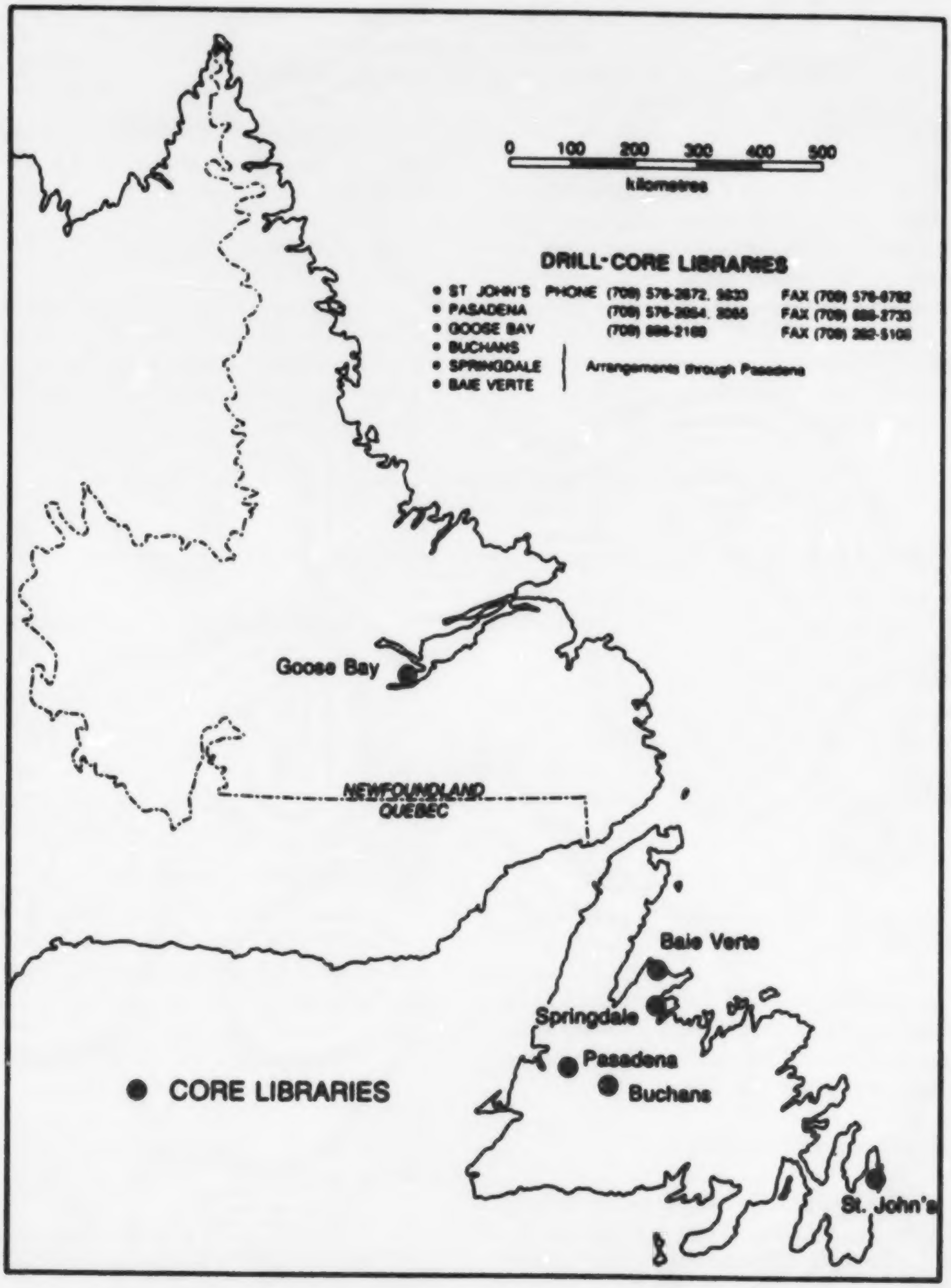

0 100 200 300 400 500
kilometres
DRILL-CORE LIBRARIES
● ST JOHN'S PHONE (709) 576-2872, 9630 FAX (709) 576-6782
● PASADENA (709) 576-2054, 2085 FAX (709) 686-2733
● GOOSE BAY (709) 896-2100 FAX (709) 282-5108
● BUCHANS
● SPRINGDALE Arrangements through Pasadena
● BAIE VERTE
Goose Bay
NEWFOUNDLAND
QUEBEC
Baie Verte
Springdale
Pasadena
Buchans
St. John's
● CORE LIBRARIES

Figure 1. *Core libraries in Newfoundland and Labrador*

all new core additions are being stored outdoors, behind the facility.

The Springdale library is operated by the resident Pasadena geologist from the Pasadena core library, on an appointment basis only. It has a core splitter and a rock saw but shares other geotechnical instruments with the Pasadena core library.

The Buchans core library contains drill-core samples from ASARCO and Abitibi-Price Ltd., which were collected when these companies were active in mining and mineral exploration in Buchans and surrounding areas. This core library is now fully operational, with the completion of an office/core examination area this year, but does not have staff assigned to it. Visits to the Buchans core library are being handled by staff from the Pasadena core library, on an appointment basis. The construction of additional core storage racks in this building during 1991 increased storage capacity by 3,000 boxes.

Core storage racks have been installed in the Baie Verte core library giving the facility the capacity to store approximately 4,800 boxes (BQ) of core samples. Renovations to the office area have been completed and this facility is now operational. Visits to this core library are also co-ordinated through Pasadena. This building will be open one day per week (every Wednesday) between October 16, 1991 to December 18, 1991 on a trial basis, to assess the need for staff in the building.

GEOSCAN - THE NATIONAL DATABASE FOR GEOLOGICAL INFORMATION: THE NEWFOUNDLAND CONTRIBUTION

Catherine Patey and Janet Gillespie
Publications and Information Section

GEOSCAN is a computerized bibliographic database of Canadian-produced and/or Canada-related geoscience documents. The GEOSCAN database and related indexes are used daily by industry and general public visitors and callers to the Section to identify documents on the geoscience of this province, as well as the rest of Canada.

The Department of Mines and Energy, Government of Newfoundland and Labrador, is one of sixteen agencies that index documents into this national database. The departmental files, including mineral assessment reports, mineral inventory cards, published reports and maps, university theses, etc., are the sources of the indexed records. Additional documents, produced and edited by related agencies, e.g., the Geological Survey of Canada, are the source of other indexed records referring to this province.

Since 1982, mainly mineral assessment file records have been added to the database. According to a survey in February, 1991, of the database and our collection of geoscientific documents on this province (e.g., Geofiles), 90 percent of the assessment files are in the database. In fact, over 80 percent of the documents in the Geofiles are referenced in GEOSCAN. This summer, basic bibliographic records for the remaining university theses in the Geofiles were entered, so that now 100 percent of the theses i.e., all 349 in the Geofiles, are represented. This fall, similar records for the remaining 450 periodicals in the Geofiles collection will be added.

As of October, 1991, there were 127,000 records in GEOSCAN, including 10,200 referring to this province. The 126,200 non-confidential records are available through on-line computer searches at the Geological Survey of Canada Library in Ottawa, at the Publications and Information Section of the Geological Survey Branch in St. John's and at the 16 other indexing agencies across Canada. The number of locally requested searches has increased each year with over 80 completed so far this year. This fall, in order to improve in-house access to the records, a user-friendly subset of GEOSCAN for the province, will be introduced utilizing CDS/ISIS software. This will be available for searching by staff and visitors. A demonstration is available at the Open House display.

References to documents referring to the geoscience of this province are also available from various printed GEOSCAN Newfoundland and Labrador indexes:

1. NTS (National Topographic System), Keyword, and Author (both corporate and personal) indexes to documents (including those authored by the Geological Survey of Canada) referring to this province with records in the database up to February 1982.

2. Computer printout sorted by NTS, with references to mineral-assessment file records entered into the database during the period 1982-1984.

3. NTS Index (with cross-reference lists) to mineral assessment file records received by the Publications and Information Section during the periods:

   - April 1985 to June 1988 (272 records)
   - July 1988 to June 1989 (Open File Nfld/1927) (628 records)
   - July 1989 to June 1990 (Open File Nfld/2068) (292 records)

A similar NTS index to mineral assessment files, received during the period July 1990 to June 1991 will be available by the end of the year. As well as these larger printed indexes, smaller custom indexes are available. Other computer printout indexes, e.g., 'Author Index to Published Documents', are available for in-house use.

Besides indexing and keying new records, improved keying and editing procedures are being developed with WordPerfect 5.0 macros, and new coding sheets are being produced. The authority files and thesauri used in coding are being enlarged, and all the terms used are being more clearly defined. These terms are maintained on various card files and binders, e.g., company name card file, mineral lands information card file, drillhole information binder, etc. The information on these card files and binders is being transferred to several mini databases on CDS/ISIS and Reflex II software for easier access and reference. These files and mini databases help to make indexing consistent and are also useful for in-house inquiries.

Suggestions for improvements are welcome and notification of any errors or discrepancies in the earlier indexes would be appreciated. For further information on GEOSCAN, please contact Catherine Patey (709) 729-6441.

MINERAL OCCURRENCE DATA SYSTEM

G. Stapleton, C.F. O'Driscoll, J. Smith and D. King
Mineral Deposits Section

The Mineral Occurrence Data System (MODS) provides information on the known mineral occurrences in Newfoundland and Labrador. It consists of a manual Mineral Inventory File and a computerized Mineral Index.

The Mineral Inventory File consists of mineral occurrence descriptions that summarize all data on known mineral occurrences in the province. The file presently contains approximately 4000 descriptions, including all mineral occurrences for insular Newfoundland (Figure 1), and selected areas in Labrador (Figure 2). The file and topographic location maps have been microfiched and duplicates are available upon request.

The Mineral Inventory File is presently being updated with new mineral occurrence descriptions. Map areas that have been updated include major parts of 12A, 12B and 12H. In addition, industrial minerals for all of Newfoundland have been documented. An industrial mineral map for the island of Newfoundland, at 1:500,000 scale on a geological base, is now available. This map contains locations, a listing and a brief description of occurrences.

Mineral occurrence maps that have updated geological bases have been published at a 1:250,000 scale and are available upon request. In addition, selected areas that have been published at 1:50,000 and 1:100,000 scales. These maps contain locations, a listing and a brief description of the occurrences.

The Mineral Occurrence Data System for Personal Computers (MODS/PC) is now available to the public. The MODS/PC database, which is primarily designed as an index to the mineral deposits and occurrences of Newfoundland and Labrador, contains information on approximately 4000 metallic, non-metallic, fossil fuel, rare-earth element and radioactive mineral deposits.

Each mineral deposit is described by a single MODS record, which has fifty-nine information fields. More detailed information on the deposit can be obtained by consulting key references listed in each record or by examining the hard copy mineral inventory reports maintained at the Geological Survey Branch, 95 Bonaventure Avenue, St. John's, Newfoundland. These reports allow information to be traced to its source publication.

The MODS/PC program is menu-driven and provides the user with complete access to the computerized inventory files. The program allows the user to search, view and output occurrences from the database. Custom designed searches are achieved by setting conditions and using Boolean logic to combine these conditions in different ways. Data portability is provided by the ability to write data to an ASCII delimited file. This allows input of a user-selected dataset to other application programs such as spreadsheets and databases or portability to other types of computer systems such as non-DOS micro-computers, mini-computers, or even mainframes. Full user documentation is supplied with the program.

The Mineral Occurrence Data System is used daily by industry, government and academic geoscientists who require information on the provinces mineral resources. It is also used extensively in land use planning.

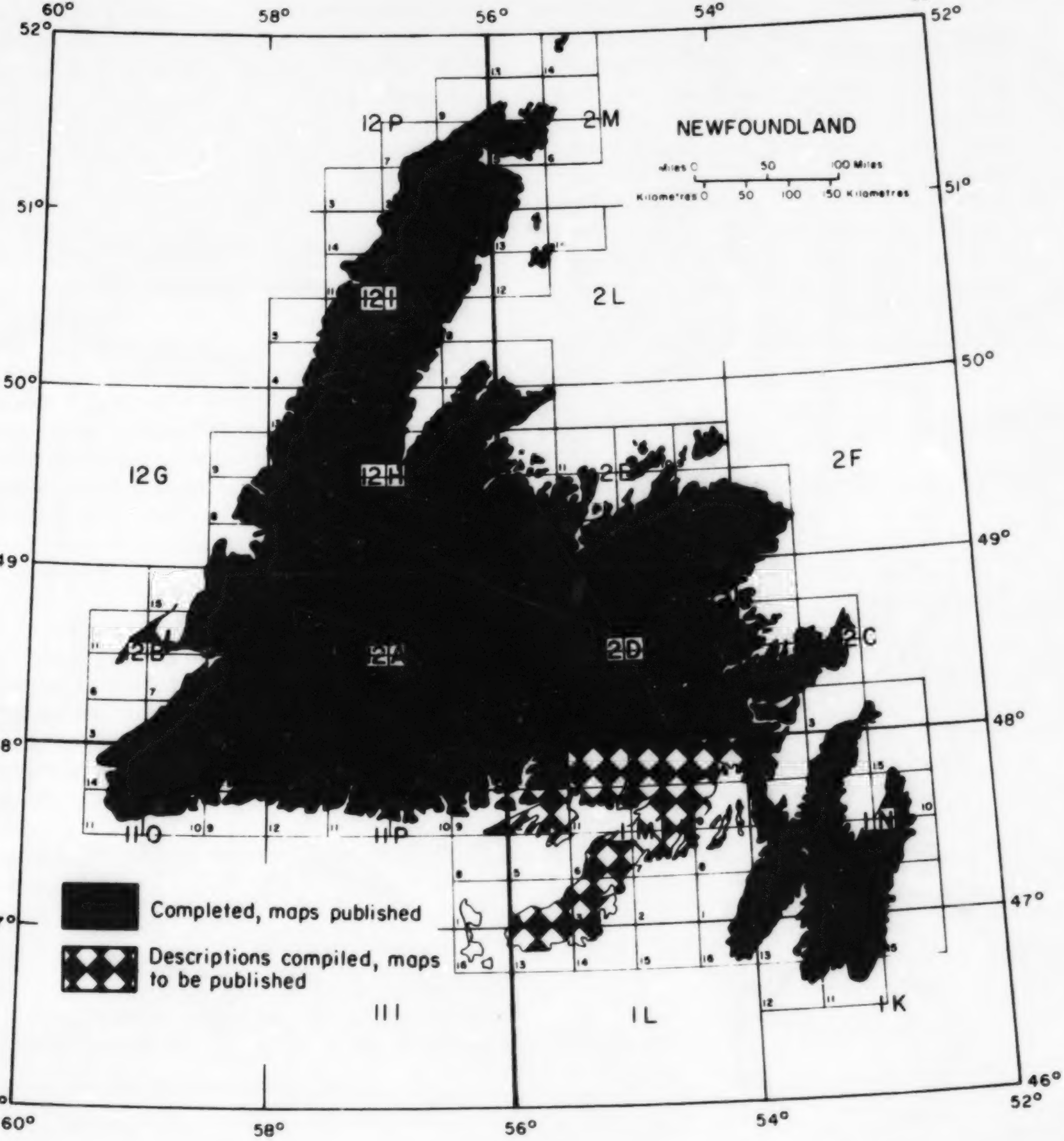

NEWFOUNDLAND
Miles 0 50 100 Miles
Kilometres 0 50 100 150 Kilometres
60°
58°
56°
54°
52°
52°
51°
50°
49°
48°
47°
46°
12P
2M
12I
2L
12G
12H
2E
2F
12B
12A
2D
2C
11O
11P
11M
1N
11I
1L
1K
Completed, maps published
Descriptions compiled, maps to be published

Figure 1. *Index map for Mineral Occurrence Data System project, insular Newfoundland.*

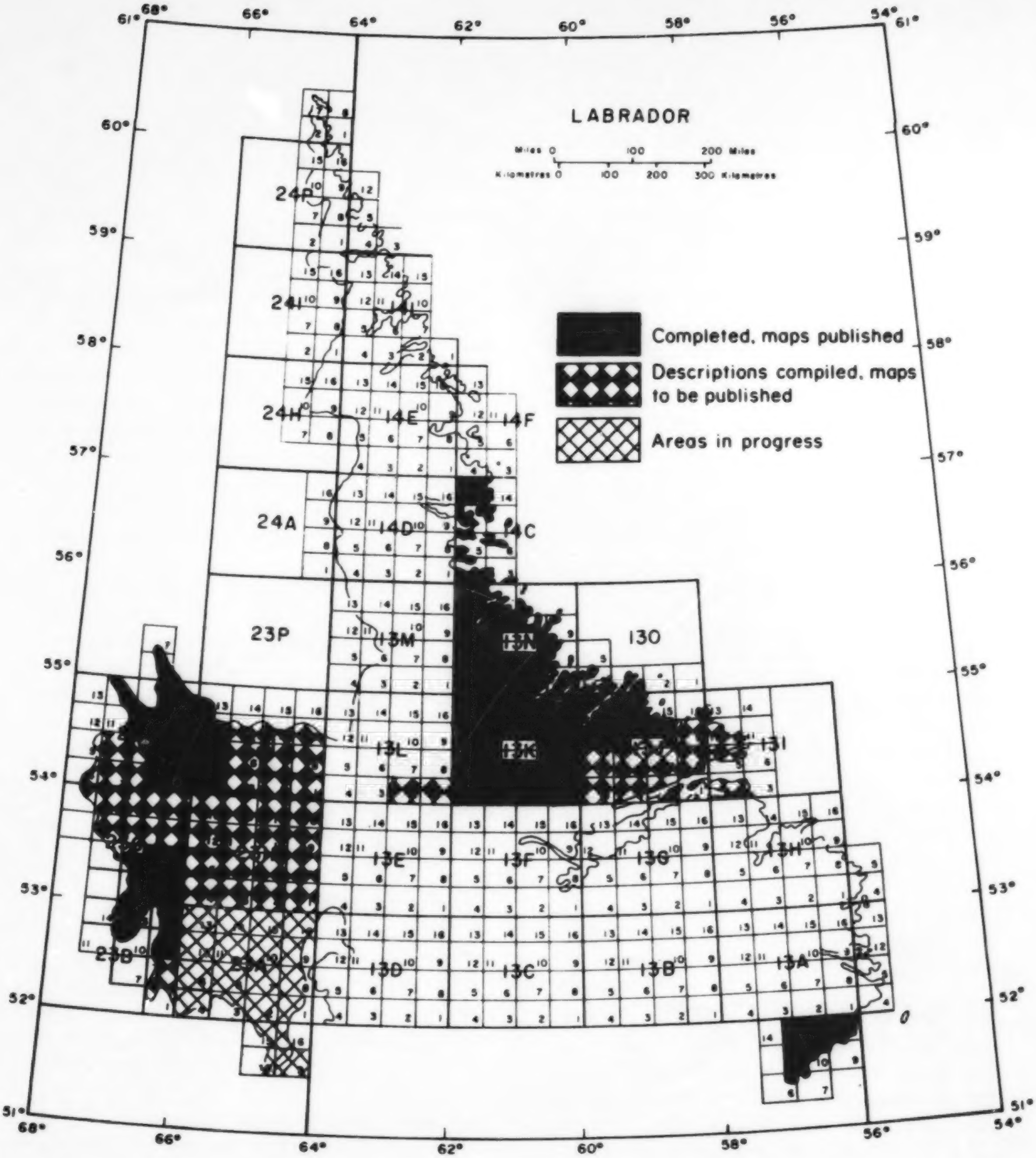

LABRADOR
Miles 0 100 200 Miles
Kilometres 0 100 200 300 Kilometres
Completed, maps published
Descriptions compiled, maps to be published
Areas in progress
24P
24I
24H
24A
23P
23B
23A
14E
14F
14D
14C
13M
13N
13O
13L
13K
13J
13I
13E
13F
13G
13H
13D
13C
13B
13A
68°
66°
64°
62°
60°
58°
56°
54°
61°
60°
59°
58°
57°
56°
55°
54°
53°
52°
51°

Figure 2. *Index map for Mineral Occurrence Data System project, Labrador*

THE GEOCHEMICAL LABORATORY

H.A. Wagenbauer and P.H. Davenport
Geochemistry and Geophysics Section

During the 12 months from September 1, 1990 to August 31, 1991, about 5,000 samples were analyzed for from one to more than 30 elements for a total of 152,296 element determinations. The total numbers of samples and determinations are very crude measures of productivity however, as the types of determination vary from single-element assays to research-quality major- and trace-element analyses of silicate rocks to rapid geochemical analyses of soil, till and drainage sediments (Table 1). Many of the trace element digestions were requested by geologists to check older analyses of dubious quality, largely carried out at outside laboratories without adequate quality control. The analysis of surface water samples for trace elements is a new service provided this year in support of projects in both exploration geochemistry (Finch *et al.*, *this volume*) and environmental geochemistry (Christopher *et al.*, *this volume*).

The geochemical laboratory maintains an archive of powders of all samples submitted for analysis, including those sent to commercial laboratories. These latter samples are prepared in the laboratory, and blind duplicates and reference standards are included in all batches. A computerized analytical request system is now in use which allows better management of lab facilities and provides a detailed record of all work requested. In addition, most analytical data are entered into a digital database, permitting systematic quality control and the reporting of results as digital files. With the arrival in 1992 of an ARL MAXIM III, a fully automated, simultaneous ICP emission spectrometer, the digital capture of analytical data will be made much more efficient. The new ICP will also significantly improve productivity to meet the extra analytical work from projects under the MDA, and allow the lab to expand the range of services it offers.

REFERENCES

Christopher, T.K., Davenport, P.H., Nolan, L.W. and Honarvar, P.
This volume: Urban geochemistry-mapping anthropogenic changes in the drainage systems of St. John's and environs.

Finch, C., Hall, G.E.M. and McConnell, J.W.
This volume: The development of analytical methods for lake and stream waters for geochemical exploration.

Table 1. Summary of output from the geochemical laboratory for the 12 months from September 1, 1990 to August 31, 1991.

ANALYTICAL OUTPUT	Samples	Determinations
Trace element analyses ($LiBO_2$ fusion) for Zr	2726	2726
Trace element analyses (HF-$HClO_4$-HCl_3 digestion) for some or all of Ag, Ba, Be, Cd, Ce, Co, Cr, Cu, Ga, La, Mo, Nb, Ni, Pb, Rb, Sr, V, Th, Y, Zn and Zr	3977	102590
Major element analyses ($LiBO_2$ fusions)	1494	24221
Trace element analyses of soil, till, sediment	912	8193
Element speciation in lake sediment	776	9533
Water analysis	160	3221
Miscellaneous assays (various digestions)	1770	1812
	TOTAL	152,296